Report of a Forestry Mission to Scandinavia

Forestry Canada Forêts Canada

Province of British Columbia
Ministry of Forests

Northern Interior Lumber Sector

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Report of a
Forestry Mission to Scandinavia

by
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March 1990

ECONOMIC & REGIONAL DEVELOPMENT AGREEMENT

Canada

BC

91-03602/

Funding for this publication was provided by the Canada-British Columbia Forest Resource Development Agreement – a five year (1985-90) $300 million program cost-shared equally by the federal and provincial governments.

Canadian Cataloguing in Publication Data

Main entry under title:
Report of a forestry mission to Scandinavia

(FRDA report, ISSN 0835-0752 ; 156)

Issued under Canada-BC Forest Resource Development Agreement.
Co-published by B.C. Ministry of Forests and Northern Interior Lumber Sector, Council of Forest Industries of B.C.
"Canada/BC Economic & Regional Development Agreement."
Includ[illegible] bibliography: p.
ISBN 0 7726-1288-9

1. Forests and forestry – British Columbia. 2. Forest policy – British Columbia. 3. Forest management – British Columbia. 4. Forests and forestry – Sweden. 5. Forests and forestry – Finland. I. Gilfillan, B.D. II. Canada. Forestry Canada. III. British Columbia. Ministry of Forests. IV. Council of Forest Industries of British Columbia. Northern Interior Lumber Sector. V. Canada-British Columbia Forest Resource Development Agreement. VI. Canada/BC Economic & Regional Development Agreement. VII. Series.

SD568.B7R46 1991 333.75'1'09711 C91-092097-4

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This is a joint publication of Forestry Canada and the British Columbia Ministry of Forests.

Produced and distributed by the Ministry of Forests, Research Branch.

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EXECUTIVE SUMMARY

A 1989 Forestry Mission to Scandinavia comprised of representatives from Forestry Canada, the British Columbia Ministry of Forests, and the Northern Interior Lumber Sector of the Council of Forest Industries of British Columbia had two purposes.

The first purpose was to examine Scandinavian developments in the following areas:

- Forest management programs;
- Land use and environment issues; and
- Long-term strategic plans and visions of forests of the future.

The second purpose was to make recommendations for British Columbia based on the Scandinavian experience.

This report reviews the history of Scandinavian forestry, describes major Scandinavian forestry institutions, details the regulatory framework within which Scandinavian forestry operates, and describes the Scandinavian silviculture regime.

While Scandinavian forests have been used for almost 700 years, the "golden age" of forestry did not begin until after World War II. The thrust of Scandinavian forestry legislation is to use timber growing capacity fully through the entire life of the stand. The legislation, which requires clearcutting, applies equally to public and private land. The majority of forest land is privately owned, and the majority of that is held by individuals.

There is a strong forestry ethic among those who work in the forest as well as within the general public.

About 57% of each of Sweden and Finland's total area is working forest, compared to only 29% in British Columbia. The Scandinavian people make heavy use of their forests for recreation. This exposure to the forests, combined with significant private ownership, leads to strong support for forestry operations. Nevertheless, the use of exotic tree species, preservation of mountain forests, and concern about certain forestry operations such as peat drainage, ditching, and fertilization are key environmental concerns. The use of herbicides for forestry is virtually non-existent because of environmental pressures in the past, but this loss of a management tool is not as serious a situation as it might be in British Columbia because the Scandinavian brush problem is not as significant. Clearcutting was also an issue about 10 years ago but today seems to be generally accepted by the public.

Most of the working forest is a managed forest, young and vibrant, suitable for intensive silviculture. There is little old growth left. The silviculture techniques used are well-known to British Columbia foresters, but the extent of their application is greater. The regime consists of clearcutting, regeneration primarily by planting, cleaning, thinning, and fertilization. Thinning is particularly important to provide much-needed wood flow and can be justified financially because of the high cost of alternative wood sources.

Timber growth under this regime is exceeding expectations. Money saved in transporting final products, because of the proximity of markets, can be spent in the forest. This regime cannot be applied in its entirety in British Columbia at this time because we must deal with a preponderance of overmature, unmanaged forests, relatively far from the markets for our final products.

The major causes of forest damage are animal browse, airborne emissions, and soil acidification, although insect attacks were epidemic in the 1970's.

Up-to-date timber inventories are conducted by organizations independent of the government and forest owners. Scandinavians use the concept of potential cut based on fibre yield rather than allowable annual cut based on utilization standards, and determine it from modelling which is updated every 5 to 10 years.

- The total volume of growing stock is the largest it has ever been and continues to increase.
- Annual growth rates are the highest they have ever been and continue to increase.
- The annual cut is less than the potential cut and has been for some time.
- The demand for wood exceeds the annual cut, the difference being made up with imports, which are often less expensive than the incremental domestic supply.

Forestry education and training in Scandinavia are both extensive and long-standing. Today, few work in Scandinavian forests without training. This education system has provided Scandinavia with a skilled and supportive work force.

Scandinavians constantly plan their forests of the future. Recent plans call for increased timber production while recognizing multiple use of the forests.

Mission members have concluded that the following key recommendations will significantly improve forest management in British Columbia:

1. **Education:** We must improve the education and knowledge base of the general public, forestry workers, and land owners not presently contributing to the working forest.

   The general public in Scandinavia have greater confidence in forestry than their counterparts in British Columbia. British Columbia should consider a forestry curriculum in the compulsory schooling program and increased communications between the forestry community and the adult population, such as field tours, open houses, and advertising, combined with appropriate written and audio visual material.

   All forestry workers should be given at least some training. There must be better coordination between technical and professional courses to permit technicians to advance. Professional courses must be more field oriented and provide a better understanding of integrated resource management. A comprehensive continuing education program must be developed for all levels.

   While British Columbia does not have the same extent of private ownership as Scandinavia, private landowners should be encouraged to keep forest land in forest production possibly through tax incentive schemes and a comprehensive extension service provided by both government and industry. If such programs fail, it may be necessary to legislate standards of forest practise on private land.

   The fundamental goal of such an education program should be to imbue all British Columbians with a strong forestry ethic.

2. **Forest Resource Goals:** We must establish what we expect from the forests by setting resource goals for timber production as well as all other uses of the forest.

   These goals should reflect increasing timber production while at the same time make appropriate allowances for other uses of the forest.

   Goals for timber production and production methods should reflect trends in manufacturing capabilities and market demand, recognizing that flexibility is a key element for our future forests.

   British Columbia should focus more on environmentally sound forest management practices than on alienating more of the working forest as a means of preserving the environment.

3. **Forest Management Techniques:** Emphasis must continue to be placed on increasing wood quantity (growth rates) and quality (growth traits) through appropriate intensive management programs. Tree improvement and fertilization programs should be expanded. A program to assess herbicides and their alternatives should begin immediately.

   All timber production programs must consider impact on other forest resources and be developed to cost effectively minimize such impacts.

   To accomplish these goals, inventories of all forest resources must be substantially improved through expansion and updating, and significantly more work must be done in growth and yield modelling of managed forests.

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1 INTRODUCTION

Forest management is continually evolving — today, driven as much by social as by scientific considerations. Public interest in our forests has never been higher and the demands put on our limited forest resources have never been greater. Society expects forest managers to provide wilderness and recreation opportunities, protect fish and wildlife habitat, maintain high water quality and produce commercial timber at a rate that will sustain the world's highest standard of living.

British Columbia's forest resources are rich and abundant, but it is clear even these great resources cannot satisfy the many demands placed upon them unless there is superior management. While demanding much from our forest managers, the public, and particularly certain interest groups, often express doubt about the validity of our forest management practises.

Our forest managers must be knowledgeable about forestry practises in other jurisdictions. We can learn from their successes and failures. This is especially true of those jurisdictions whose forest resources and conditions resemble those of British Columbia, yet whose forest use evolved earlier than that of British Columbia.

Scandinavia's boreal forests closely resemble much of British Columbia's interior forests, yet they have been in use and under management much longer. Much has already been learned from Scandinavia and applied in British Columbia. But, the perception held by some is that Scandinavia is still ahead of British Columbia in forest management techniques.

In light of this, a tripartite group of representatives from the British Columbia Ministry of Forests, Forestry Canada, and the Northern Interior Lumber Sector participated in a Forestry Mission to Sweden and Finland from 26 May to 11 June 1989. Appendix 1 contains a list of Mission members and the Mission itinerary.

The Mission had two main purposes:

1. To examine Scandinavian developments in:
   - forest management programs;
   - land use and environmental issues; and
   - long-term strategic plans and visions of forests of the future.
2. To make recommendations for British Columbia based on the Scandinavian experience.

FIGURE 1. Large lodgepole pine stock grown in the SCA Bogrundet Tree Nursery.

2 COMPARATIVE STATISTICS

Remarkable similarities exist between Scandinavian forests and those of British Columbia, but there are also fundamental differences. When considering recommendations made in this Report it is important to have some basic facts in mind (Table 1).

TABLE 1. Comparative statistics for Sweden, Finland, and British Columbia

	Sweden	Finland	British Columbia
Population	8.4 million	4.9 million	3.1 million
Total forested area	26 million ha	22 million ha	52 million ha
Working forest	23 million ha	19 million ha	28 million ha
Forest ownership			
Public	26%	28%	94%
Companies	24%	8%	5%
Individuals	50%	64%	1%
Standing volume	2700 million m^3	1700 million m^3	8900 million m^3
Species			
Spruce	47%	37%	23%
Pine	38%	45%	19%
Deciduous	15%	18%	4%
Others	0%	0%	54%
Allowable (or potential) annual cut[a]	90 million m^3	67 million m^3	74 million m^3
Current annual harvest[a]	67 million m^3	54 million m^3	74 million m^3
Annual production			
Wood products	12 million m^3	9 million m^3	39 million m^3
Pulp	11 million tonnes	9 million tonnes	7 million tonnes
Paper	9 million tonnes	8 million tonnes	3 million tonnes
Forest employment			
Direct	142 000	100 000[b]	87 000
Indirect	70 000		174 000

[a] Sweden and Finland use the concept of potential, rather than allowable, annual cut. British Columbia figures for allowable cut and annual harvest are for Crown-regulated lands only. The cut from private lands not part of a regulated unit in British Columbia was 13.7 million m^3 in 1989.

[b] This is a combined estimate for direct and indirect forest employment.

What are some of the significant points that can be drawn from these statistics?

First, about 29% of British Columbia is working forest, while the working forest comprises 57% of each of Sweden and Finland. This has important implications for land use decisions and how people view the forest.

Second, more than 70% of forests in Sweden and Finland are privately owned, whereas in British Columbia only about 6% of forest land is in private ownership. This ownership pattern affects public regulation of forestry and industrial structure, as well as land use and perceptions of the forest.

Third, the allowable annual cut per unit area of working forest is lower in British Columbia than in either Sweden or Finland, even though British Columbia has substantially more standing timber volume. This is, in part, a function of forest structure and silviculture treatments.

3 HISTORICAL OVERVIEW

Scandinavia has a long forest history, dating back almost 700 years. The forests were first used for fuelwood and were subjected to clearing for farmland. As early as the late 13th century, limitations were placed on the right to clear forest.

By the 16th century, Finland was exporting firewood and axe-hewn timber beams. At about the same time, Sweden was taking steps that would continue into the early 19th century to establish oak plantations to meet naval requirements.

Sometime in the latter part of the 16th century, and continuing for almost three centuries, huge demands were put on the central Swedish forests for charcoal to supply iron works. It is estimated that charcoaling consumed 4 to 5 million m^3 per year during its peak, affecting over the period of the iron works between 3 and 4 million hectares of forest land.

The advent of steam power and a move away from the mercantile philosophy ushered in an established sawmilling and paper industry in the early and late 19th century respectively. The rejection of mercantilism also led to a massive sell-off of public lands to individuals, mostly farmers. By the early 20th century, forest companies had purchased significant tracts of forest land from farmers, but that practise was severely limited soon thereafter and has remained limited ever since.

When the forest industry began a rapid expansion in the mid-1800's, Scandinavia was largely an agrarian society. In many areas the forests had been depleted, and the regulatory efforts aimed at protecting rather than managing the timber resource were not equal to the demands that would soon be placed on the forest. Fortunately, the growth in forest industries during the latter half of the 19th century was accompanied by a growing awareness of the need to manage the forests.

The first forestry laws of any significance were introduced in Finland in 1886 and in Sweden in 1903. At about the same time, government organizations were established to manage public forests and to monitor activities on private forests. Public interest in forest management was evidenced by a new and growing folk movement — tree planting.

The initial laws were aimed at preventing the devastation of forests by requiring regeneration after harvesting. These were followed in the early 20th century with laws prohibiting the felling of young forests except for the purposes of thinning.

Despite a long history of forest use, and apart from certain notable exceptions, Scandinavia has practised forest management for a relatively short period. The "golden age" of forestry did not begin in Scandinavia until after World War II, about the same time the rapid expansion of the forest industry in the Interior of British Columbia got underway. Its impact is demonstrated by the enormous increases in growth rates and growing stock since 1952, as shown in Table 2.

TABLE 2. Increase in Sweden's growing stock and increment, 1952–1982

	% Increase
Growing Stock (total m^3)	44%
Growing Stock (m^3/ha)	40%
Increment (m^3/year)	46%
Increment (m^3/ha/year)	41%

These gains in growing stock and increment were earned in only thirty years because of modern forest management. This is a key lesson to be learned. The Scandinavian experience tells us that success in forest management can be achieved in a short period.

4 MAJOR INSTITUTIONS

Forest management is the responsibility of four major sectors in Sweden and three in Finland (Figure 2). In Sweden, those sectors are the National Board of Forestry and Domän (a state-owned forest company) on behalf of the state, the private forest owners, and the forest companies. Finland has only three sectors because it does not have a counterpart to Domän.

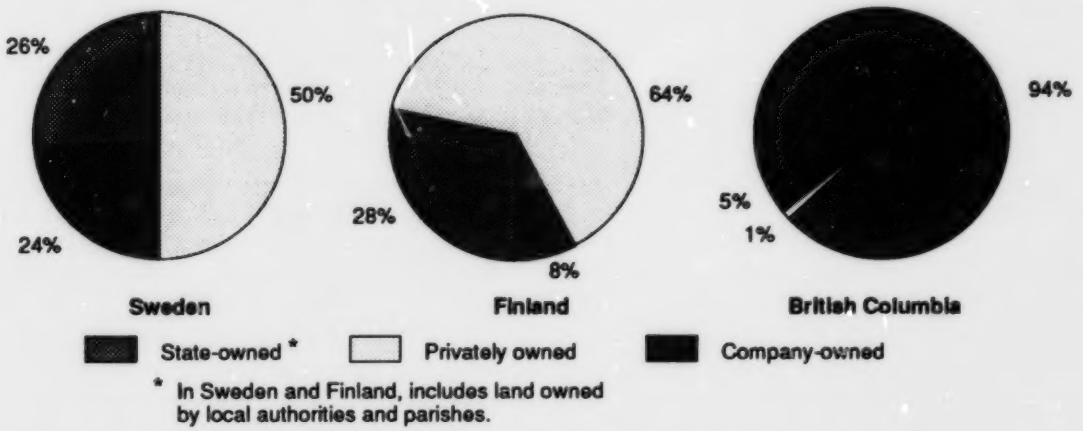

FIGURE 2. Comparison of forest land ownership in Sweden, Finland, and British Columbia.

4.1 The National Board of Forestry

In Canada, the two senior levels of government (federal and provincial) each play a role in forestry, although primary responsibility for forest management rests with the provinces. Scandinavian countries have only one senior level of government. Its forestry administration, the National Board of Forestry, most closely resembles the provincial Ministries of Forests. The main duties of the National Board are:

- application of the Forestry Act;
- extension services for forest owners and others;
- information to other authorities and organizations, schools, the general public, and visitors from abroad;
- distribution of state grants and subsidies for silviculture, road construction, and other forest management activities;
- inventory and development of forestry plans; and
- participation in community planning, forecasting, and keeping statistics.

Sweden's National Board of Forestry employs about 2400 full-time and 4200 part-time employees, compared to approximately 3500 FTE's in B.C.'s Ministry of Forests. The main differences between the National Board of Forestry and B.C.'s Ministry of Forests are:

- the National Board regulates forest practises on private as well as public lands (although private land regulation is expected in British Columbia soon);
- the National Board emphasizes extension work to private owners whereas the Ministry emphasizes integrated resource management; and
- the National Board does not administer development or harvesting programs such as the British Columbia Small Business Forest Enterprise Program.

4.2 Domän

Domän, the state-owned forest enterprise in Sweden, manages all forests belonging to the Crown, amounting to 3.7 million hectares, or about one-fifth of Sweden's productive forests and twice the forest area managed by the next largest owner. In addition to harvesting 6.7 million m^3 per year, Domän operates several sawmills, provides wood to state-owned pulp mills and manages agricultural land, rental housing, and several other ventures. Although state-owned, the forest management practises of Domän are subject to the Forestry Act and are overseen by the National Board of Forestry.

4.3 Private Owners

Although Domän is the largest single owner of forest land in Sweden, it is individual owners who manage the majority of forest land in both Sweden and Finland.

There are some 200 000 individual forest owners in Sweden and almost 300 000 owners in Finland (Figure 3). About 85 000 of the Swedish forest owners, owning some 5.4 million hectares of forest land, are members of one of 12 forest owners' associations, the largest having about 25 000 members. Finland has only one main forest owners' association, which has approximately 125 000 members.

The main functions of the associations are to:

- conduct roundwood sales;
- conduct felling and silvicultural activities;
- process the timber of their members and market the resulting manufactured products; and
- provide information and further education for their members.

FIGURE 3. In stark contrast to British Columbia, much of the Scandinavian forest is divided into many small parcels owned by hundreds of thousands of individuals.

4.4 Forest Companies

While there are many forest companies in Scandinavia, the industry is dominated by a very few world-class operations. Of the world's fifty largest forest products companies in 1989, three were Swedish (Stora Group 5th, SCA 17th, and MoDo 20th) and four were Finnish (the highest ranking being Kymmene at 27th). By comparison, six Canadian companies made the list, the highest being Noranda Forest at 14th. MacMillan Bloedel, British Columbia's largest company, was 23rd. Table 3 provides a comparison of industry size.

TABLE 3. Comparison of forest industry size between Sweden, Finland, and British Columbia

	Sweden	Finland	British Columbia
Sawmills			
number	300	175	216
annual production (million m^3)	11.4	7.5	37
Panel Board Mills[a]			
number	21	36	25
annual production (million m^3)	1.7	1.2	2
Pulp and Paper Mills			
number	112	77	24
annual production (million tonnes)	17.4	16.5	10

[a] includes plywood, veneer, particle board, and similar products

Three features of the Scandinavia forest industrial structure are not found in British Columbia. First, Sweden operates state-owned manufacturing plants. Second, individual forest owners in both Sweden and Finland have joined together in forest associations which operate significant manufacturing facilities. Third, two large and unrelated Finnish companies (Kymmene and Oy Tampella) jointly own and operate a timber supply company called Tehdaspuu Oy. Tehdaspuu provides 11.4 million m^3 of wood per year to its two shareholders. It also manages 450 000 ha of forest land owned by its shareholders, from which it obtains 9% of its total annual wood requirements.

4.5 Other Institutions

Additional organizations play an important role in Scandinavian forest management. Among them are trade associations having purposes similar to British Columbia forest industry trade associations. Research and education institutions which play an important role are described briefly in Sections 10.1 and 10.2 of this Report.

5 THE REGULATORY FRAMEWORK

Until the late 19th century, forestry legislation was aimed at protection, rather than management, and yielded poor results. Neither the Finns nor the Swedes consider the earlier efforts as true forestry laws. The first forestry law of significance was introduced in Finland in 1886 and in Sweden in 1903, only a few years before British Columbia's first significant forestry law, the *Forest Act* of 1912. Throughout the 20th century, Scandinavian forestry legislation has evolved.

- First, the law required management on a sustained yield basis and harvested areas to be reforested (no stand tending was required).
- Later, harvesting in young forests was restricted to rationale thinnings.
- Then, a requirement that consideration be given to environmental amenities was added.

- Subsequently, government agencies were empowered to compel timber harvesting by way of clear-cutting where stands are over-age and the productive capacity not achieved, and to force cleaning or thinning where immature stands are stagnating.
- Finally, a specific law was enacted to protect certain indigenous broad-leafed trees (excluding the species used to produce primary forest products) by prohibiting, in the absence of government consent, either harvesting or replacement with another species after harvesting.

Appendix 2 contains a more detailed description of the Swedish Forestry Act.

In comparing Scandinavian forestry law to that of British Columbia, the following are some key points.

- The Scandinavian Forestry Acts apply equally to state-owned and privately owned (whether individual or company) forest land.
- The thrust of Scandinavian legislation is to use timber growing capacity fully through the entire life of a stand.
- Clearcutting is **required by law** in Sweden.
- Based on traditional rights there is, subject to limitations, common access to private and public land for the purpose of picking berries, flowers, and mushrooms, and for general recreation.

6 LAND USE AND ENVIRONMENT ISSUES

Forest lands in Sweden and Finland fall into three broad categories (Table 4) for the purpose of land use:

- those areas where no commercial forestry activities are permitted;
- those areas where forestry is permitted subject to certain limitations; and
- the working forest which is subject to nature conservation considerations.

TABLE 4. Three categories of forest land use and percent of total area included in each

	Sweden	Finland	British Columbia
Forestry not permitted	1%	3%	5%
Forestry limited	4%	8%	
Working forest	57%	57%	29%

6.1 Reserve Areas

Neither Finland nor Sweden is projecting significant increases in the areas in which forestry is either prohibited or limited. Finland estimates that by the year 2000 approximately 3–4% of the country's total potential allowable annual harvest will be unavailable due to prohibitions or limitations as a result of single or multiple use of forest lands. While a similar estimate is not available for Sweden, it is reasonable to conclude that the total impact on Sweden's allowable annual harvest is less than the percentage of land area set aside and not significantly different from the Finnish projections, since some of the protected area is not forest land and some of it is forest land of low productivity.

While 57% of total land area in Sweden and Finland is working forest, only 29% of British Columbia is working forest. The smaller percentage for British Columbia is due primarily to natural factors (i.e., water, rock, and other non-productive areas). But it is also influenced by the amount of working forest society chooses to take out of commercial timber production and designate for other uses.

6.2 Management Issues

In addition to special restrictions in areas where forestry is limited, the Swedish Forestry Act provides for the issuance of regulations which address "nature conservation aspects" in the working forest, such as the size and form of clearcut areas, the establishment of new stands, the leaving of tree groupings, and the location of forest roads. Forest operators are advised that:

- trees and other vegetation on swampy and rocky land are to be saved;
- nesting trees are to be saved, and places with rare plants to be left untouched; and
- final felling areas are to be planned so as not to be too much of an eyesore in their surroundings.

The general public make heavy use of Scandinavian forests. In Sweden, 80% of urban residents walk in the forest now and then; 40% of urban residents walk in the forest more than 20 times each year; 40% of urban residents go fishing each year; over 300 000 people spend an average of nearly 30 days hunting each year; and more than 100 million litres of berries and mushrooms are picked in the Swedish forests annually. Yet, despite this heavy use, the overall day-to-day management of Scandinavian forests seems little concerned with the environmental issues so prevalent in British Columbia.

- There are virtually no old-growth forests left in Sweden.
- The protection of fresh water habitat for salt-water fish is not a widespread concern because there are only two salmon-bearing rivers left in all of Sweden and Finland, the rest no longer supporting anadromous fish populations because of dams built many years ago.
- Wildlife populations are generally on the increase, and moose and deer populations are increasing dramatically because forest management is providing good habitat for these animals.

6.3 Environmental Issues

The main environmental concerns about Scandinavian forest management appear to be, in order of priority:

- use of exotic tree species;
- preservation of mountain forests; and
- forestry operations such as peat drainage, ditching, and fertilization.

6.3.1 Exotic tree species

Scandinavians have conducted field trials on exotic species, including black spruce (*Picea mariana*), subalpine fir (*Abies lasiocarpa*), white spruce (*Picea glauca*), Siberian fir (*Abies sibirica*), Siberian larch (*Larix sibirica*), and broad-leafed species, including certain species of aspen.

Norway spruce provenances from central and eastern Europe are often used in northern Sweden, apparently without significant concern on the part of environmentalists, perhaps because the species is native to Sweden.

The Swedes began planting lodgepole pine (*Pinus contorta*) from the Yukon and northern British Columbia about 60 years ago. To date, about 400 000 hectares have been planted to lodgepole, about one-half of that by one company — SCA. By 1975, lodgepole pine made up about 25% of Sweden's planting stock.

While lodgepole pine outperforms native species by 30 to 50% on suitable sites, and has not experienced significant difficulties in adapting to Scandinavia, some environmentalists argue against the use of any exotic species.

As a result of pressure from environmentalists, the Swedish National Board of Forestry has set planting limits on lodgepole pine of approximately 27 000 hectares per year. Within 25 years, it is estimated that lodgepole will make up not more than 10% of the planting stock in areas where it is traditionally used (primarily the northern half of Sweden).

6.3.2 Preservation of mountain forests

Strong environmental pressures in Sweden resulted in the establishment of some 50 special areas totaling approximately 600 000 hectares of virgin pine and spruce forests near mountain areas, primarily in northwestern Sweden. The stated purpose of these reserves is "to preserve large 'untouched' forests for future use." Environmental concerns do not relate to re-establishing forests after harvesting in these areas but, rather, towards assuring recreational opportunities and protecting reindeer breeding. Most of the forests in question are state owned and only about 16% of the total area set aside is productive forest. That forest area is generally low in productivity. The ultimate use of these forests is yet to be determined and timber production has not been precluded.

6.3.3 Forestry operations

A number of forestry operations -- particularly drainage, ditching, and fertilization — concern the environmentalists.

Both Sweden and Finland have a comprehensive program of swamp drainage to create productive forest land in an effort to increase long-term timber production. Between 1900 and 1982, Finland drained some 5.5 million hectares of swamp, 4.7 million hectares of which were drained since 1951. The area drained in Sweden has risen to about 20 000 hectares per year, requiring in excess of 10 000 kilometres of drainage ditches. It appears, however, that partly from pressure by environmentalists and partly because of diminishing returns, the practise of drainage will subside in the future. Finland has predicted that all new drainage will be completed by the year 2000.

Ditching as a method of site preparation has been equally under criticism and now requires special permits before it is allowed. One example we saw seemed to create significant site disturbance (Figure 4).

FIGURE 4. Ditching used to prepare a site for replanting after failure following mechanical site preparation and planting. An adjacent area prepared by prescribed burning was well established.

Environmentalists have also raised concerns about the effects of fertilizer use in addition to nitrification of waterways. Special concerns have arisen because fertilization lowers the pH of soils whose quality has already deteriorated because of "acid rain." Since "acid rain" is a bigger problem in the south than in the north, regional rules have been developed permitting more fertilization in the north than the south. Fertilization treatments in Sweden have declined from an annual rate of 2% of the productive forest area down to about 1%. The rate in Finland has also declined by about 50% since the early 1970's, but, interestingly, is projected to return to that level (about 200 000 hectares per year) by the year 2000, in an effort to increase growing stock.

6.3.4 Issues of special interest to British Columbia

Three environmental issues which have arisen in Scandinavia are of particular interest to British Columbians — clearcutting, prescribed burning, and pesticides.

Clearcutting

As noted earlier, clearcutting as the final felling is mandated by law in Sweden and extensively practised in Finland. Table 5 provides a comparison of the extent of clearcutting.

TABLE 5. Annual clearcutting in Sweden, Finland, and British Columbia in hectares and as a percentage of the working forest (variations in area occur from year to year)

	Sweden	Finland	British Columbia
Area (ha)	230 000	150 000	240 000[a]
% of working forest	1.0%	0.8%	0.9%

[a] Annual average for the 5-year period 1984/85 to 1988/89

Table 5 clearly shows that, contrary to what is often suggested in British Columbia, the amount of clearcutting in Scandinavia, expressed as a percentage of the working forest land base, is virtually identical to British Columbia.

What is different between the jurisdictions is the size of openings. In Sweden, guidelines suggest that clearcuts be limited to 20 hectares in the south and 40 hectares in the north. Many clearcuts in the south are much smaller than the suggested limit, the average size being between two to four hectares. In the north, clearcuts can be of 100 or more hectares in size, but the average is between eight to ten hectares. In Finland, the size of openings is smaller, averaging about 2 hectares. In British Columbia it is not unusual for openings to be 100 hectares, and sometimes larger, although there is a trend to smaller sizes.

While public pressure played a role in Sweden's introduction of suggested limits on clearcut sizes, the land ownership pattern also has a strong influence on the average opening size. Since 50% of the forest land in Sweden and 63% of the forest land in Finland is owned by individuals holding small parcels — an average of 45 hectares in Sweden and 35 in Finland — it is not surprising that clearcuts average much less than 100 hectares in size (Figure 5). This is in contrast to British Columbia where 94% of the forest land is public, much of it in parcels hundreds of thousands of hectares in size.

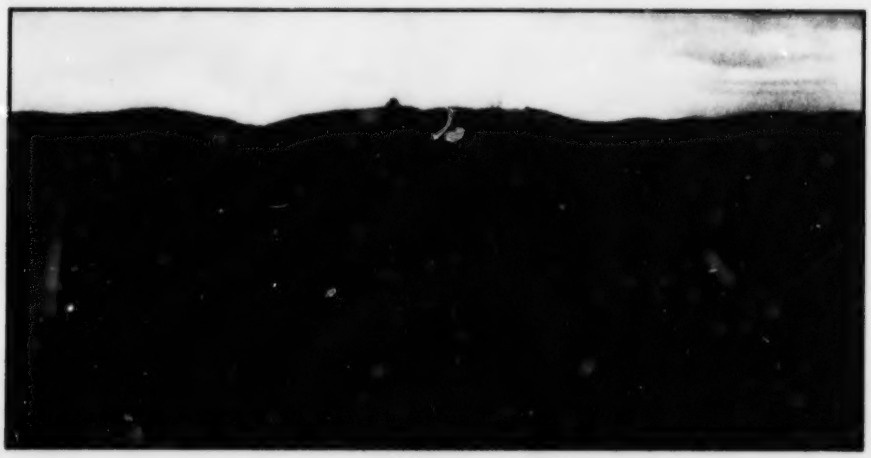

FIGURE 5. The land ownership pattern restricts the overall average size of clearcuts, but where land holdings are larger, so are the block openings (background).

About ten years ago, there was some controversy in Sweden about clearcutting and suggestions by environmental groups to move to selective logging. However, the argument against clearcutting failed for at least five reasons. First, the Scandinavian forests are ecologically suited to clearcutting. Abundant evidence of the destructive nature of selective logging in Sweden's timber types exists in the forests that resulted from the extensive use of that practise in the late 19th and early 20th centuries. It was that hard-learned experience which moved the Swedes to mandate clearcutting by law. Second, because of the relatively small size of openings, one may stand in a clearcut and see adjacent areas which were clearcut earlier and now support vibrant new growth (Figure 6). Third, because clearcutting has been extensively practised for some 75 years and because intensive forestry has been ongoing for almost 50 years, there are many examples of clearcutting working through successive rotations. Fourth, because the forests harvested in Scandinavia are generally very young and vibrant, most of the wood felled is used, leaving very clean harvesting sites with little logging residue. Aesthetically, this is much more pleasing than logging in overmature and decadent forests which often results in at least some unusable residue left on the ground. Fifth, as noted in Section 6.2, the general public in Scandinavia spend time in the woods. This permits them to observe first hand the successes of clearcutting and regeneration practises, so they are not as easily influenced by external sources as is the more urbanite British Columbian.

FIGURE 6. Newly established forests can easily be seen from most clearcuts.

Prescribed burning

From being common practise in northern regions, very little prescribed burning is now used in either Sweden or Finland, primarily because of land ownership patterns and expense, but also because of objections from forest workers. Small land holdings increase the chance of escape into another owner's timber, making fire liability a major issue. Overall, the Swedish attitude toward prescribed burning seems more negative than that of the Finns. On many sites, Scandinavians have found that prescribed burning has outperformed mechanical site preparation techniques both in regeneration and in maintaining site productivity. For these reasons, Scandinavians are considering an increase in burning, especially in the northern regions.

Pesticides

Although there are few limits on the use of pesticides for domestic or agricultural uses, there are severe limits on the use of herbicides, insecticides, and fungicides in forestry.

In Sweden, limitations have been in effect for many years and the use of herbicides in commercial forestry will be completely banned as of 1990. Most Swedish forest managers moved to other treatments long before the deadline. MoDo, for example, voluntarily stopped the use of herbicides in 1971. In Finland, aerial spraying of herbicides is completely banned. Ground applications are still permitted but require a permit from the local community, which is rarely granted. These constraints appear to have been imposed primarily for social reasons, rather than as a result of scientific studies demonstrating negative environmental impacts.

The loss of herbicides is not as serious in Scandinavia as it would be in British Columbia. There is not as much brush in young forests in Scandinavia as there is in British Columbia and the brush is mainly woody and can be cut, unlike the herbaceous material which is a problem in British Columbia.

To minimize their brush problems, Scandinavians clearcut, site prepare and plant quickly, and plant in high densities. Where these techniques fail to control the brush, they employ primarily motor manual saws at higher costs than herbicide applications. Work is ongoing to develop brushing machines to reduce costs. Some are now in production.

7 SILVICULTURE

Scandinavian silviculture is both advanced and simple. It is advanced in that it is a total system over the rotation. All phases are coordinated to provide treatments that meet predetermined targets in volume and quality. It is simple in that forest ecosystems do not have the complexities of British Columbia's forests. They have only three native commercial species: Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), and birches (*Betula* species). The topography is fairly flat and the soils mainly coarse textured. The silvicultural systems used are similar to those used in the central interior of British Columbia; however, they are done as a total regime over a rotation, not as individual stand treatments. Treatments have proven to be very successful. New forests are exceeding earlier predictions in both quantity and quality.

Rotation periods in Scandinavia are generally 70 to 110 years in the south and 80 to 140 years in the north. The average mean annual increment (mai) is about 3.5 m^3/ha/year, but intensive management is expected to increase that average to 5 or 6 m^3/year, with maximum mai anticipated to be 12 to 15 m^3/ha on the best sites. Annual increment is higher in the south (5.3 m^3/ha/year) than in the north (2.0 m^3/ha/year). At the time of harvest, southern crops average 30 m in height and 30 cm in dbh on good sites while northern crops average 15 m in height and 20 cm in dbh.

Clearcutting is the predominant harvesting method. Some private owners, wishing to save the expense of planting, rely on seed trees taken in a final clearcut felling after a new crop is established through natural regeneration (Figure 7). Even in this approach, clearcutting and not selective logging is the silviculture system of choice.

A forest owner must submit a plan, indicating how the forest will be harvested and regenerated, to the local County Forest Board at least 30 days before harvesting is to commence on areas exceeding 0.5 ha. If the Board does not comment on the plan within the 30 days, the forest owner may proceed with his plan. These plans give the County Forest Boards, in consultation with the County Environment Authority, an opportunity to consider whether the proposed cutting should be forbidden or modified for environmental reasons.

Much current Scandinavian silviculture has developed to address poor past practises and present day reluctance of many private owners to manage their lands for timber production. By the 1930's many Scandinavian forests were severely depleted. There was an enormous amount of backlog not satisfactorily restocked (NSR) land and also a shortage of middle-aged stands. At the end of the 1930's, for example SCA, one of Sweden's largest land owners, found that two-thirds of its forest land was backlog NSR.

FIGURE 7. To reduce the expense of regeneration, some private owners rely on seed trees to establish the next crop. When the new crop is established the seed trees are removed in a final clearcut felling.

A four-part strategy was adopted to address the resulting poor age-class distribution.

- The poorest quality stands on the best sites were harvested first to bring them back to vibrant production as soon as possible.
- Fertilizing in older stands was accelerated to increase growth rates.
- Fast-growing new stands were established using *Pinus contorta*.
- Longer rotation periods were introduced in areas where young stands had been harvested too early.

This program is generally viewed as having worked beyond expectations. Concerns about the lack of middle-aged stands, which remained high just ten years ago, now seem to be subsiding.

Extensive thinning operations have also been adopted to address wood supply shortages. These shortages have two primary causes. The first is the age-class structure problems referred to above. Thinning does not rectify this problem, but it provides a much-needed wood supply while it is being addressed. The second cause is the removal of privately held forest land from active timber production. These removals are attributed to a tax structure which discourages harvesting and to the inheritance of such land by urban dwellers who have little interest in forest management and are not reliant on the forest for income.

7.1 Tree Improvement

The Swedish tree improvement program is coordinated under the Institute for Forest Improvement (the "IFI"), an independent organization separate from government, industry, and the private land owners. The organization works cooperatively to provide research direction to the tree improvement program. Individual companies or the government maintain seed orchards.

Established by forest owners in 1936 as an association for forest tree breeding, this group initially produced tree seedlings for forest plantations. In the 1950's, it shifted its focus to establishing and managing seed orchards. By 1967, it had evolved into the Institute for Forest Improvement, responsible for:

- breeding of forest trees in Sweden; and
- research and development work on tree breeding and forest fertilization.

The activities of the Institute are jointly funded (50/50) by the Swedish state and the forest land owners. Operating under the guidance of a Board, with equal representation between state and forest owners, the Institute undertakes both directed and service work on breeding and mass propagation.

The Board of the Institute works within a continuous 10-year program, the first 3 years of which have s. ured funding. Program funding for tree improvement is about Cdn. $4 million per year, split by species as follo.ys:

Species	Cdn. $ million/year
Scots pine	1 – 2
Norway spruce	1 – 2
Lodgepole pine	0.2 – 0.4
Birch	0.1
Hybrid aspen	0.03

The Institute maintains a staff of about 80 people, which include 12 tree breeders for four species of concern (Scots pine, lodgepole pine, Norway spruce, and birch). The Institute does breeding research and progeny testing, locates seed orchards, performs grafting, and provides advice on tree improvement. Genetic evaluation of progeny and creation of new breeding generations are important parts of the Institute's work.

The Institute itself owns no seed orchards but assists the seed orchard owner (which may be a single company or group of companies) with selection and grafting of suitable progeny and provides extension and research support for the management of seed orchards. Third-generation orchards have been started in some species. Lodgepole pine is well established in seed orchards. SCA have five such orchards and expect to start a second-generation orchard in the near future (Figure 8).

FIGURE 8. One of SCA's five lodgepole pine seed orchards.

The general aim of the breeding program is to improve timber quality, increase volume (genetic gain is estimated at 15–25% over the rotation) and improve frost hardiness. The latter is a serious problem affecting seedling growth in the northern areas of Sweden and frost sensitive low-lying areas in south Sweden.

The British Columbia Interior Tree Improvement Program is similar to Sweden's in that it is directed to a limited number of species. However, whereas the Swedish IFI has 12 breeders, the British Columbia Interior has only three — one for each interior species.

As British Columbia companies become more conversant with tree improvement programs, it may be prudent for the British Columbia Tree Improvement Councils to consider moving to the Swedish Institute model, whereby companies contribute financially to the research aspect of tree improvement. There are two advantages. First, longer term financial planning may be possible. Second, companies will have a greater vested interest in research into tree improvement and will want to be assured that the work of the tree breeders is directed in areas of importance to them.

7.2 Regeneration

7.2.1 Artificial vs. natural regeneration

About 90% of harvested areas in Sweden are regenerated by planting or sowing, the latter being a very small program. In Finland, 50% of the harvested areas are regenerated by planting or sowing (30% planting; 20% sowing) and 50% by natural regeneration. By comparison, it is estimated that planting comprises about 60% of British Columbia's regeneration program. Most of the natural regeneration in Sweden is carried out by private land owners who accept longer regeneration delays in return for lower regeneration costs and, to a lesser extent, a feeling that they are following a more natural management regime.

In Finland, the split between planting and natural regeneration seems to follow site quality closely. Good and medium sites are planted and poorer quality sites are left to regenerate naturally. Finns also report that there is pressure to move to more natural regeneration because of the high cost of planting, the lack of a silviculture workforce, and, to a lesser extent, concerns among environmentalists about planting leading to monoculture. They are also predicting a slight shift by the year 2000 from planting to sowing. Swedes are also looking at increasing natural regeneration in mid- and southern Sweden to about 25%, but they are also expecting a decrease in reliance on natural regeneration in the higher latitudes and higher elevations. Overall, the reliance on natural regeneration for Sweden is not expected to change. Natural regeneration is generally used only in Scots pine, but some successful natural regeneration is also experienced in spruce. Where natural regeneration is relied on, about 75–125 seed trees per hectare are left on the clearcut area.

For Sweden as a whole, the species breakdown for planting is: 46% Scots pine; 36% Norway spruce; 17% lodgepole pine; and 1% deciduous. There are dramatic local variations from these coniferous averages, depending on site conditions and on the responsible manager's faith in lodgepole pine.

Whether regeneration is by planting, sowing, or seed trees the maximum regeneration delay in Sweden is typically three years.

7.2.2 Nursery management

The Swedes plant about 500 million seedlings per year; the Finns about 200 million. This demand requires a substantial nursery program. In Sweden, about 75–80% of seedlings are container grown, whereas in Finland only 60% are container grown. There are about six container systems on the market. Finns reportedly prefer peat or paper pots, but we observed extensive use of plastic containers at company nurseries operated by MoDo and SCA in Sweden (Figure 9).

The SCA nursery — the Bogrundet Tree Nursery — is the largest in the world, producing some 75 million seedlings per year from 400 kilograms of seed. The sowing process is highly automated. Each plastic seedling container tray holds 67 pots; each container one seed. The nursery can sow up to one million seeds per day. After sowing, the containers are placed in metal frames, holding 60 trays apiece, and are handled in those frames from the sowing shed through all growing and transportation processes until they are ultimately delivered to planters in the field. The frames, holding the containers and the seedlings, are transported to the field in trucks each capable of carrying 300 000 seedlings. The trucks return the empty containers in the frames from the bush to the nursery (Figure 10).

The Bogrundet nursery is able to produce 75 million seedlings a year by force-growing four crops from March to August each year. The first crop is planted that year, and the other three the following year, after over-wintering in open-air beds (Figure 11).

While Scandinavian nurseries are more automated than those in British Columbia, seedling quality is not graded and, overall, the quality of stock appeared to be less than that of British Columbia stock. Scandinavians seem to compensate for lower stock quality through good site preparation, planting more seedlings per hectare, and intensive stand tending after planting.

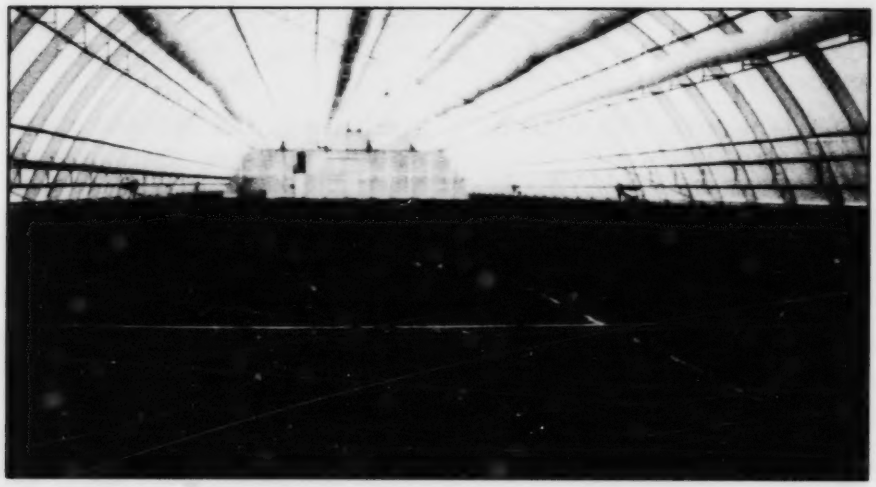

FIGURE 9. A MoDo greenhouse showing plastic containers in metal frames.

FIGURE 10. At SCA's Bogrundet Tree Nursery, empty frames from the field are removed from the transport truck and full frames are loaded for delivery to the planting sites.

FIGURE 11. Stock is overwintered in open-air beds and may be sprayed to ward off the pine weevil which attacks plantations.

7.2.3 Site preparation

Site preparation is necessary to prepare plantable spots, warm the soil, and reduce losses from the pine weevil (*Hylobius* sp.). The weevil is present in duff and will girdle new seedlings. Exposing mineral soil around the seedling discourages the weevil from leaving the duff. As in northern British Columbia, cold soil temperature is often a limiting factor to growth, and exposing the soil and rock raises the temperature and enhances early growth (Figure 12). Because harvested stands are relatively young and not generally subject to waste, decay, or breakage, there is little debris left after logging to impede planters, but plantable spots can be increased through site preparation on sites which are particularly wet or rocky.

Site preparation is usually done the year after harvesting, although there appears to be a trend to speed the regeneration process by preparing sites immediately after harvesting.

FIGURE 12. A rocky site prepared mechanically.

Swedes report that about 90% of clearcut areas are treated by mechanical means, mainly disc trenching, mounding, and plowing. Of these methods, disc trenching is the most popular, accounting for about 65% of the treated area for all of Finland and about 85% in southern Finland. Plowing has raised environmental concerns but is still quite common in northern Finland where, unlike Sweden, an environmental permit is not required. As in British Columbia, mounding is popular on wet sites, accounting for about 25% of all mechanical treatments in Sweden, and is expected to gain in popularity, but costs about 25% more than disc trenching. Figures 13 and 14 show a new type of mounder, recently made available for use in British Columbia. Little prescribed burning is done, although some foresters think it would be better for some sites than mechanical methods, and we saw evidence to that effect. Many sites are very rocky and could be difficult for equipment. Depending on terrain and equipment, productivity in mechanical site preparation ranges between 0.5 and 1.0 hectares per hour.

FIGURE 13. View of a new model of excavator-mounted mounder.

FIGURE 14. A close-up view of the new mounder recently introduced in British Columbia.

7.2.4 Planting

Harvested areas are generally planted the year after the site is prepared, although there is a trend to reduce the regeneration delay by planting in the same year as site preparation.

In Sweden, the Forest Law requires in most cases that at least 2100 seedlings be planted per hectare. General practise is to plant between 2200 and 2400 per hectare, and in some cases even more. In Finland, the average is slightly lower at about 2000 seedlings per hectare, but still substantially above the British Columbia average of 1200 seedlings per hectare in the Interior and 800 seedlings per hectare on the Coast. High densities are employed as protection against browse problems, relatively high seedling mortality, and the possibility of future diseases. The higher densities also assist natural pruning and increase wood density (both popular with a solid wood industry seeking high-value products) and provide stems for thinning, which creates a much-needed wood flow over a significant period in the life of the stand.

Swedes aim for some 2200 surviving seedlings per hectare after two years. Survival rates in the south are about 90 to 95%, but in the north considerably less. Bareroot plantations were reported by one company to be twice as likely to fail as container plantations.

Planting productivity varies depending on the planting system, the planting conditions, and the method of payment. Finns reported that, under similar conditions, bareroot planting with a mattock averaged 600 seedlings per day, whereas tube planting averaged 1000 seedlings per day. On easier terrain in the south, productivity can rise to 2200 seedlings per day compared to 1300 to 1600 in the central areas. A similar contrast exists when a piece rate is used (average 2200 seedlings/day) compared to an hourly rate (average 1300 to 1600 seedlings/day).

Where the plastic container system is used, the planter straps two containers at a time to his or her belt (67 seedlings in each container) and plants one container while walking away from a central storage site and one while returning to the storage area to pick up another two containers (Figure 15). Container-grown seedlings are planted with a tube.

Attempts to mechanize planting have been ongoing for 20 years but are yet to be successful. The most successful prototypes have averaged 1400 seedlings per production hour, but are considered only partially practical.

FIGURE 15. A planter with two seedling container trays and planting tube.

7.3 Stand Tending

Stand tending in Scandinavia is divided into three important categories: cleaning or pre-commercial thinning; thinning; and fertilization.

7.3.1 Cleaning

In Sweden, the Forest Law has required since 1979 that young stands be cleaned before they reach a height of 3 metres, and the general practise is to do so when trees reach 1.5 to 2 metres. Between 80 and 90% of the 450 000 hectares which the Swedes estimate should be cleaned each year are treated. In 1986, the Finns cleaned almost 260 000 hectares and are aiming for 335 000 hectares per year by the year 2000.

Herbicides are generally not available for cleaning. Hand cleaning with a brush saw is the dominant method, with productivity averaging about 0.1 hectare per hour (Figure 16). Apart from the new mounder, the only new silviculture equipment of potential interest for British Columbia is that used for cleaning. There have been rapid advancements in mechanized cleaning in Scandinavia since 1985. In 1988, about 1% of cleaning was done by machine in Sweden, but this is expected to rise to 10% by the mid-1990's. The Swedish experience indicates that cleaning machines are economically competitive in stands where more than 10 000 stems per hectare are to be removed (Figure 17, 18). Productivity for these machines is about 0.2 to 0.3 hectares per hour.

On more productive sites it may be necessary to do up to three cleanings. However, hardwood competition often is not completely eliminated at the cleaning stage. First, frost damage is a significant problem in Scandinavia, and the presence of hardwoods can eliminate frost pockets and reduce damage to conifers. Second, moose and deer browse is also a major problem, and leaving deciduous trees provides an alternate food source during the part of the year when deciduous trees are in leaf. Third, some deciduous species (birch in particular) are commercially valuable and can be utilized from a thinning. As a result, it is not unusual to leave 1500 birch stems per hectare after cleaning, most of which will come out in the first thinning.

FIGURE 16. Hand cleaning, or pre-commercial thinning, with a brush saw is the dominant method used in Sweden.

FIGURE 17. Cleaning machines have been shown to be economically competitive in stands where more than 10 000 stems per hectare were to be removed.

FIGURE 18. Close-up view of cleaning machine's cutting tool.

7.3.2 Thinning

Subsequent to the cleaning mandated by law, thinnings are rationalized on the basis of growth and yield, the cost of wood, and wood supply needs. Up to three commercial thinnings may take place during a rotation, although the optimum number is not widely agreed upon. Thinning is widely practised and contributes 25% of the annual volume harvested in both Sweden and Finland. About 150 000 hectares in Finland and some 225 000 hectares in Sweden are thinned each year. The importance of thinning is expected to increase over time as large areas of young stands reach thinning age. In Finland, thinning is expected to increase by 70% between 1986 and the year 2000. Growth and yield seem to be well understood, and that understanding is translated into detailed thinning schedules identifying size, density, and quality limits.

A typical thinning regime might begin with a first thinning at age 30 to 40 years when the trees would be about 10 metres high and have a density of about 1600 to 2000 stems per hectare. This thinning would reduce the density to about 1000 stems per hectare, recover 60 m^3 per hectare, and produce about 10% sawlogs by piece count. A second thinning might occur at age 55 to 60 years, leave about 500 stems per hectare, recover 80 m^3 per hectare, and produce nearly 20% sawlogs by piece count (Figure 19). The final felling would take place at age 95 to 100 years, recover about 350 m^3 per hectare, for a total volume recovery over the harvest sequence of about 500 m^3 per hectare.

Both motor manual (chainsaws) and mechanized methods are used for thinning, although mechanization appeared more common in Sweden (Figure 20). In either case, operators are well trained and little, if any, damage is rendered to the residual stand in the thinning process. In fact, branches from the thinnings are put down ahead of the machines to reduce soil compaction (Figure 21).

FIGURE 19. Pulp logs taken from a thinning operation.

FIGURE 20. Valmet thinning processor in 65-year-old Scots pine, removing 400 stems and 46 m^3 per hectare.

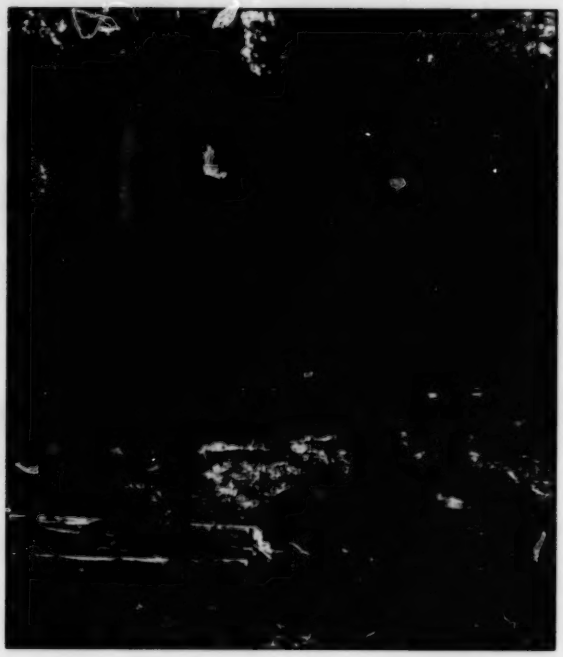

FIGURE 21. Branches on skid trails in a 46-year-old stand minimize site damage from equipment.

7.3.3 Fertilization

In the mid-1960's a fertilization program was started. It peaked in the 1970's, has since declined somewhat, but is projected to increase in the future, at least in Finland. Presently, about 150 000 hectares per year in Sweden (mostly in the central and northern areas) and about 100 000 hectares per year in Finland are fertilized (Figure 22). Approximately 2 million hectares had been fertilized in both countries by the early to mid-1980's. In Sweden there are restrictions on fertilizer use, particularly in the south, due to soil acidification.

Fertilization is mainly directed to maturing stands. The common practise seems to be to fertilize after the first thinning at around age 50 years and every 7 to 10 years thereafter. Pine stands on medium sites appear to be the most common target.

Application is primarily by aircraft, but ground methods are also used. The typical application rate is 150 kg/ha of pure nitrogen applied as 450 kg/ha of ammonium nitrate. The increase in growth rates as a result of fertilization range from 10 to 30%. Overall, the growth effect is estimated to contribute about 2 to 3 million m^3 to Sweden's annual increment.

7.4 Mixed Wood Management

About 15% of Sweden's and 18% of Finland's standing timber volume is deciduous. In both countries, birch is the dominant deciduous species, accounting for almost 75% of Swedish and more than 80% of Finnish deciduous standing volume. In Finland, aspen and alder account for 3% of total standing timber volume. In Sweden, beech and oak account for slightly less than 2%. The proportions of deciduous and coniferous standing volumes have been relatively constant for many years.

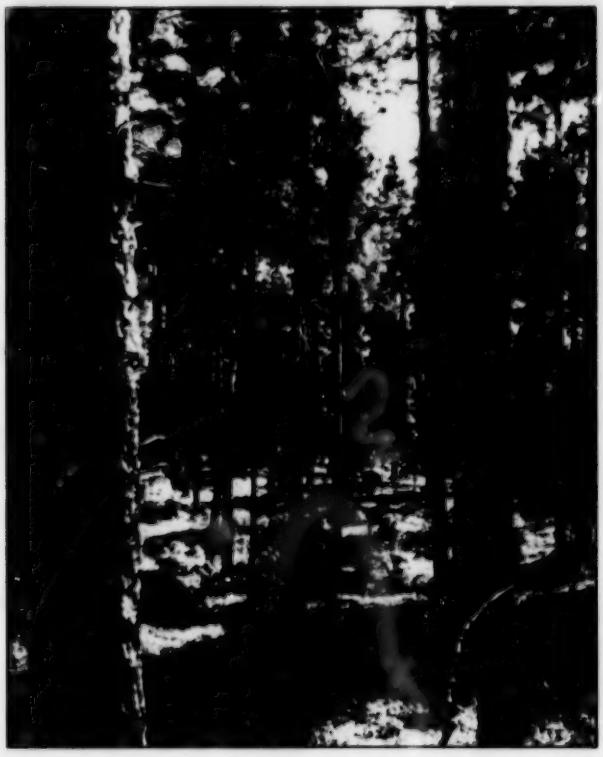

FIGURE 22. Some older stands (about 100 years old) are responding to a regime of thinning and fertilization.

Birch is by far the most commercially important of the deciduous species, finding use mostly in plywood and pulp. Birch is the primary species in plywood production and makes up 80% of the pulp used to produce fine papers. Pulp production accounts for 90% of deciduous wood consumption in Sweden and probably a similar amount in Finland. Presently, deciduous species account for almost 13% of total roundwood consumption in Sweden and contribute about 20% of annual Finnish harvest volume. Although Swedes do not anticipate an increase in the importance of deciduous species, Finns believe their use in pulp will grow by 2.4% per year between 1980 and the year 2000. By way of comparison, in British Columbia in 1987/88, deciduous species made up less than 1% of the harvest, but by 1995 are predicted to make up some 5%.

Despite the relative importance of deciduous species in commercial production, neither the Swedes nor the Finns seem to concern themselves very much with deciduous management. A few foresters seem to hold deciduous species in contempt.

During the 1960's and 1970's, Swedes did not increase the total area of young stands cleaned each year. This led to what Swedes describe as a critical situation around the late 1970's and early 1980's when cleaning was urgently required to decrease the admixture of naturally regenerated and rapidly growing deciduous species. This crisis led to a 1979 amendment to the Forestry Law making pre-commercial thinning a compulsory measure. Cleaning is now seen only second in priority to stand establishment as the nation's highest silviculture priority. Although speculation on our part, it may be that this cleaning fervour caused the virtual banning of herbicides in forestry. Initially, cleaning was accomplished with herbicides. Herbicides, however, were bitterly opposed by a public who often travelled in the woods and consumed liberal amounts of berries and game. This opposition eventually led to the banning.

Scandinavian foresters are not totally opposed to deciduous growth in coniferous stands. The deciduous species reduce frost pockets and provide an alternative source of food for browse. Some deciduous stems are often left after cleaning, to be taken during the first thinning (Figure 23).

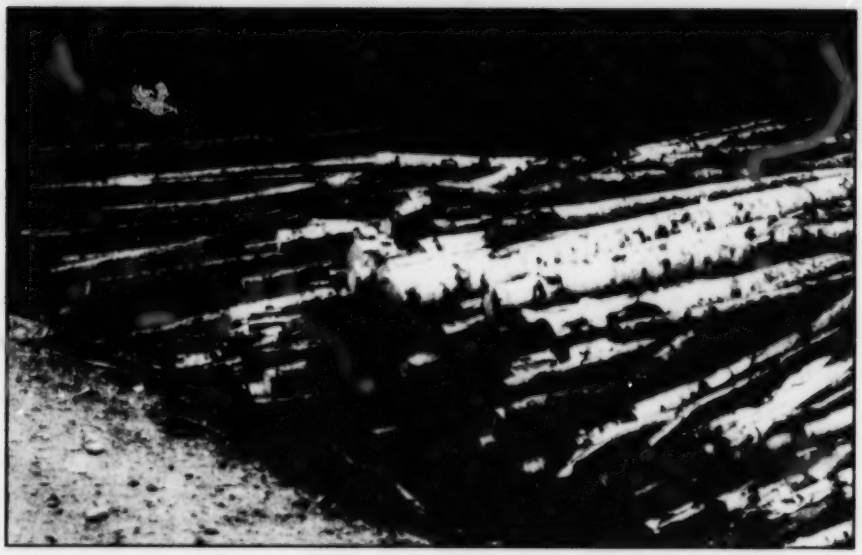

FIGURE 23. Birch and pine logs taken during the first thinning.

Overall, however, mixed wood man[illegible]ment does not seem to be a priority. The reason for this appears to be a large supply of very low-pri[illegible]ch from the Soviet Union. So long as such a supply exists, Scandinavians will probably focus o[illegible]producing the more valuable conifers in their own forests and satisfy much of the demand for deciduous species through imports.

7.5 Silviculture Costs

As in British Columbia, silviculture costs vary significantly in Scandinavia depending on site condition, labour availability, restrictions on forest management practises, and other factors. Table 6 presents estimates of average cost for five comon silviculture treatments.

TABLE 6. Estimate of average cost for each of five silviculture treatments in Scandinavia

Treatment	Cost (Cdn. $)
Site preparation	$170/ha
Reforestation	$700/ha
Cleaning	$180/ha
Thinning (including planning and wood delivery)	$24/m³ or $1500/ha
Fertilization	$180/ha

7.6 Applicability to British Columbia

Several features of Scandinavian forestry which distinguish it from the British Columbian situation suggest that the Scandinavian silviculture regime cannot presently be applied in its entirety in British Columbia. At the root of many of these distinguishing features is time.

Because of 700 years of extensive forestry and almost 50 years of intensive forestry, much of the Scandinavian working forest is a managed forest, there being little old growth left. These managed forests are young and thrifty and their growth patterns are well understood. The management emphasis is on

maximizing growth (quality and quantity) in stands which, because of their young age and vigour, are capable of responding to silviculture treatments such as thinning and fertilization. Money, which might otherwise go into transportation costs for the final products, can be spent in the forests because markets are nearby. British Columbia, in contrast, has a relative abundance of unmanaged and overmature forests which will economically supply our forest industry for several years to come. Management of these components of our working forest focuses, first, on minimizing losses related to decay, disease, and infestation through orderly harvesting and, second, on converting these harvested sites into productive forests through application of basic silviculture treatments.

While there is some second growth harvesting in British Columbia, the industry is not yet dependent on managed forests for a commercial timber supply, nor would extensive thinning be economically attractive. Although there are many second-growth forests in British Columbia, they have not been intensively managed over a long time and the impacts of silviculture treatments on growth and yield are not well understood. It will likely be some time before wood supply from thinning becomes an appropriate alternative to old-growth harvesting within British Columbia's working forest. The current chip surplus makes the creation of additional pulp material financially unattractive. Until there is a shortage of pulp fibre, it is unlikely there will be significant commercial thinning in British Columbia.

In addition to forest structure, the longer history in Scandinavia has allowed better integration of forestry, manufacturing, and marketing. Scandinavians understand what quantity and quality of wood their forests can yield under various management regimes. They have matched this to their markets and manufacturing capabilities, and they manage their forests accordingly. In British Columbia, the industry must take the raw material which an unmanaged forest yields. Some qualities are better, yet many are worse, than what a managed forest would produce. As we move to a more managed forest, the opportunity will exist to better integrate timber management with manufacturing capability and market demand, bearing in mind that flexibility should be a key element when producing forests for the future.

8 PROTECTION

Forest protection issues in Scandinavia are different from those in British Columbia.

8.1 Wildfire

While British Columbia concerns focus on wildfire and insect attack in over-mature forests, the primary concern in Scandinavian is forest damage caused by animals and by airborne emissions and acidification.

Although wildfire was at one time a significant problem in Scandinavia, it is so miniscule an issue now that forest fire statistics are no longer kept in Sweden. Abundant summer rainfall, a humid climate, and well-developed access roads help to minimize wildfire problems. Swedes have replaced a large fire control organization with private flying clubs who control fire on a contractual basis at a low cost to the public.

8.2 Insects

Insects pose a much greater threat in Scandinavia than wildfire. Those causing the greatest problems include the pine weevil, the pineshoot borer (*Tomicus* sp) and spruce bark beetles (*Pityogenes chalcographus* and *Ips typographus*). The pine weevil attacks young seedlings and is combatted through proper site preparation and, in some cases, the use of insecticides in the nurseries, although there is some objection by planters to this practise. Swedes report their greatest insect problems come in older stands following wind-throw. The largest attack occurred after heavy wind storms in 1969, when both spruce and pine were attacked. An extensive control program, including the use of more than 350 000 pheromone traps, was instituted. The attack was brought under control but Swedes do not know whether to attribute their success to control measures or to natural causes.

Major insect outbreaks peaked in the late 1970's, just as Sweden introduced detailed rules in the Forestry Act for prevention and control. These rules include measures to be taken:

- in forests damaged by storm, snow, fire, or otherwise;

- with cleaning, clearing, and logging residues;
- on extraction of timber to roadside;
- after severe insect attacks; and
- when storing timber.

It may be no coincidence that insect problems in Sweden have declined since the introduction of these rules. A description of these measures is attached in Appendix 3 to this Report.

An insect worthy of special mention is the pinewood nematode. All Scandinavian countries presently have a ban on the import of wood chips from the southern United States because in 1984 the pinewood nematode was discovered in a chip shipment destined from there to Finland. In 1990, the nematode was discovered in a shipment of white pine lumber from the Maritimes to Finland. This could have serious implications for Canadian lumber shipments not only to Scandinavia but also to the more important markets of the United Kingdom and continental Europe.

8.3 Diseases

Only two diseases were reported: a needle cast and a disease caused by the fungus *Gremmeniella abietina*, which is primarily a concern with lodgepole pine. Weakened lodgepole pine are thought to be the most prone to infection. Some foresters in Sweden claim that lodgepole pine is weak because it has been planted on sites to which it is not adapted, such as wet or high elevation sites. They believe lodgepole pine could fail on those sites, with or without the fungus. The SCA company, the strongest supporter of the lodgepole program, believes that lodgepole pines have been weakened by a recent heat sum problem in Sweden. SCA believes that if temperatures experienced in 1987 became the norm, Sweden's tree line would drop 300 metres.

8.4 Animals

Other protection problems pale in significance when compared with browse damage caused by moose and roe deer (Figure 24). The problem has become so severe on Scots pine in southern Sweden that it limits planting of this species. Foresters blame the situation on a high moose population caused by two factors. First, there is a great deal of browse material available because of the non-use of herbicides and because cattle are not permitted to graze in the forest. Second, many small clearcut areas regenerating rapidly provide excellent moose habitat. The moose population in Sweden has grown from only 10 000 animals in the 1940's to about 300 000 animals today, about one moose per 100 hectares of forest land. Hunters take about 130 000 moose and a similar number of deer each year and foresters believe that number should be increased.

FIGURE 24. Typical browse damage in young stand established by natural regeneration.

8.5 Air Pollution and Soil Acidification

Since 1980, Scandinavians have become increasingly concerned about forest damage caused by air pollution, primarily sulphur dioxide and nitrogen oxides originating from continental Europe. The problem seems to be most severe in southern Sweden but is being monitored across the country in forest inventories. A national survey in 1984 showed that spruce forests over 60 years of age in southern Sweden suffered from extensive needle loss. In the southernmost regions, 20% of the trees in middle and older-aged spruce forests have needle loss exceeding 20%. About 1% of spruces have needle loss exceeding 60%. The problem has now spread to the spruce forests of inland northern Sweden where the trees are older and often exposed to stress under severe climatic conditions.

The only real solution to this problem is to reduce harmful emissions, but that is difficult when the vast majority of emissions originate in other countries. In the meantime, good silviculture and forest hygiene are emphasized. Young stands are cleaned and thinned before they become so dense that tree crown resistance is weakened. Nitrogen fertilization is restricted in southern Sweden. Soil liming is being used, but with mixed results and adverse impacts on tree propagation. Finally, damaged stands are logged on a priority basis.

9 TIMBER MANAGEMENT

9.1 Inventory

In Sweden, national forest inventories are conducted by the Department of Forest Survey of the Swedish University of Agricultural Sciences. In Finland, inventory work is performed by the Finnish Forest Research Institute. The first national inventory was carried out in Sweden between 1923 and 1929. It was a systematic strip inventory, measuring all trees within 10-m-wide strips. The second national inventory was carried out between 1938 and 1952, primarily using circular sample plots of 6.64 m in radius. In Finland, systematic forest inventories have been continuously underway since the 1920's and cover the entire country.

The present Swedish national inventory is a low-intensity sample conducted across the entire country, producing annual estimates of volume and growth. Although the survey is carried out by the university, its annual cost of approximately Cdn. $3 million is paid for by the government, notwithstanding the large proportion of private ownership.

Placing inventory responsibilities with the university has the advantage of building close ties between faculty members, students, and the forestry community. It also lends credibility to the results because the university is seen to be independent of the government and the forest owners. Although independent, the university does work closely with the forestry community. The result is an inventory in which all people seem to have confidence.

In addition to the general inventory, there are operational inventories for management planning which the Swedes estimate cost about Cdn. $12 million per year.

9.2 Allowable Annual Cut

Both the Finns and the Swedes use the concept of potential cut rather than allowable annual cut, the Swedes having made the switch in terminology about 40 years ago.

Potential cut is determined through computer modelling conducted by the organizations also responsible for the general inventories. Again, in Sweden the cost of modelling is paid for by the government. The Swedes have conducted remodeling every 5 or 10 years since the 1950's, the last study being done in 1985 and the next scheduled for 1992.

The modelling process appears to be much more simple than that employed in British Columbia. There are two reasons for this. First, when compared with Scandinavia, British Columbia has a greater number of potential uses of the forest which must be taken into account in the modelling process. Second, in Scandinavia modelling is not used to set an enforceable allowable cut, but only to demonstrate the potential cut.

9.3 Timber Supply

There are some remarkable facts about Sweden and Finland's timber supply.

- The total volume of growing stock is the largest it has ever been and it continues to increase.
- Annual growth rates are the highest they have ever been and they continue to increase.
- The annual cut is less than the potential cut and has been for some time (Figure 25).
- The demand for wood exceeds the annual cut, the difference being made up with imports, which are often less expensive than the incremental domestic supply.

By comparison, British Columbia is, on average, cutting its full allowable annual cut (as determined by current utilization standards) and does not rely on any significant degree of wood imports. However, while Sweden and Finland anticipate higher allowable or potential cuts, British Columbia may be facing a long-run sustained yield of less than the current allowable annual cut. There are at least two apparent reasons for this dichotomy. First, Scandinavia has largely made the transition from old growth to managed forests. Second, having made that transition earlier than British Columbia, the Scandinavians also recognized earlier than British Columbia the need for intensive forest management to offset potentially lower yields per unit area as a result of harvesting stands before growth has completely stopped. This intensive regime includes early replacement of the most decadent stands, early elimination of backlog NSR, reduction of regeneration delay, use of faster-growing species, cleaning, and fertilization. The Scandinavians might also include thinning in this list, while others would argue that thinning contributes to wood flow, but does not increase potential cut.

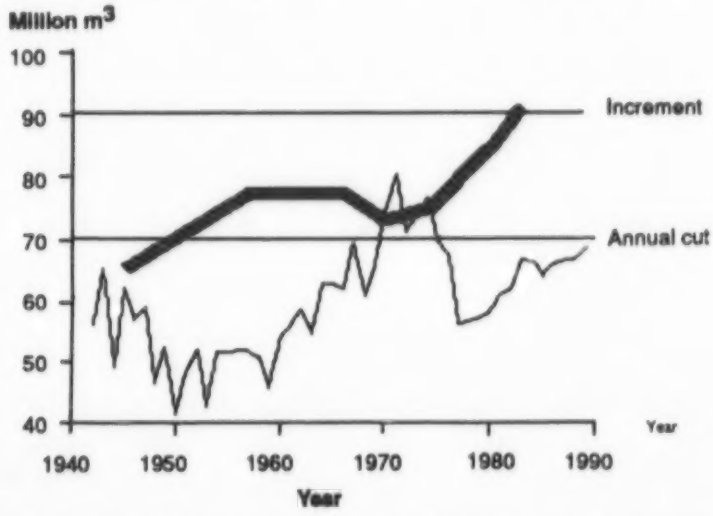

FIGURE 25. Sweden's annual cuts and increment since the 1940s. Source: National Board of Forestry, 1988.

9.4 Private Owners

The greatest problem in Scandinavian timber supply is that the potential cut is not being harvested. This shortfall between potential and actual cut is occurring on land owned by individuals. State-owned and company-owned forests are being cut at, and in some cases slightly above, the modelled potential cut. But so much land is owned by individuals that the harvest rate on that land can have a heavy impact on the country's overall deficit between potential and actual cut.

One cause for this deficit on private land is changing lifestyles. Years ago, the land was owned by farmers who lived on or near the land, relied on timber harvesting for income, and had managed their forests as part of their lifestyle and livelihood for many years. The Scandinavian population today is increasingly urban. The urban dwellers generally have jobs unrelated to commercial timber production, but living in the city as they

do, they value the forests for recreational purposes. More and more forest land is coming into the hands of urban people through inheritance. Unlike their family before them, they do not live on or near the land, they do not rely on timber harvests for income, and they have not worked at forest management. These factors, combined with their view of the forest as a recreation site only, have adversely impacted on the harvest contribution from private lands. A second cause of this deficit is a tax system which can tax virtually the entire profit from a harvest on private land. Thus, land owners often only cut when they need additional funds, rather than on an ongoing basis.

Governments have taken some action and have under consideration further action to bring these lands back into active timber production. Legislation has been enacted which forces harvesting when a timber stand starts to stagnate. The law also requires that such harvested land be regenerated and tended after harvesting. Under consideration are taxation changes which would make it unattractive to delay timber harvesting past an optimum date. A third alternative might be to permit forest companies to purchase the land, but it does not appear that this option is being pursued actively at this time.

Forest companies and Forest Owners' Associations are taking some action to encourage landowners to manage their properties. Most companies and associations prepare and circulate to landowners in their area detailed brochures on forest management. Forest company brochures also suggest to the owner that, in return for the right to acquire the timber harvested, the company will reforest and tend the land to meet the requirements of the Forestry Act.

This extension service seems to be working well and is expected to increase in the future. These programs provide important lessons for those segments of the British Columbia forest industry dependent on timber from private and agricultural-lease lands.

10 STRATEGIC ISSUES

10.1 Education and Training

Forestry education and training in Scandinavia is both extensive and long-standing. Intensive forestry education began in Sweden in 1828 and in Finland in 1862. Today, few work in Scandinavian forests without training. All students take 9 years of compulsory comprehensive school. After that, they can choose three forestry paths, broadly categorized as forest worker, forestry technician, and professional.

About 30 educational establishments in each of Sweden and Finland provide the training necessary to become a forest worker or forestry technician. Each country graduates about 800 forest workers and in excess of 100 forestry technicians each year. Forestry programs at this level can last from one to four years and usually involve some vocational experience.

Professional education is offered at two universities in Finland and one in Sweden, the latter having three campuses. The degree programs are four to five years. In Sweden, the students take first year at one campus, second and third year at a second campus, and fourth year at either the second or a third campus, depending on their specialization. In Finland, students choose between one of the two universities for their full education, depending on their interest areas, the newest of the two universities being more specialized. Sweden graduates about 60 foresters each year, Finland about 80. A degree in forestry provides the student with the knowledge, responsibility, and analytical competence needed to manage the natural resources of the forest. Students are educated not only for forest management, education, and extension services, but for other tasks such as nature conservation and community planning where a combination of biological, technical, economic, social, and business competence is required. The foregoing is a simplification of the Scandinavian education and training system. Figure 26 provides an idea of its true complexity.

From our observations, the education system has provided Scandinavia with a skilled and supportive work force. Wherever we went, both logging and silviculture workers appeared very skilled at their jobs and were knowledgeable about how their job fit into the management regime of the overall operation. It was very noticeable that all workers appreciated the forest for more than just providing them with a job. They recognized the forest as an asset to the country and their employer, to be managed with great care. Many appeared to

use the forest for recreation as well as employment. All were supportive of forest management. A further advantage of training appeared to be reduced supervision for the workers, as they were knowledgeable about job functions and supportive of the need to do a good job. Most organizations had very flat organization charts. A training and forestry education system such as that in Scandinavia would do much to improve forest management in British Columbia.

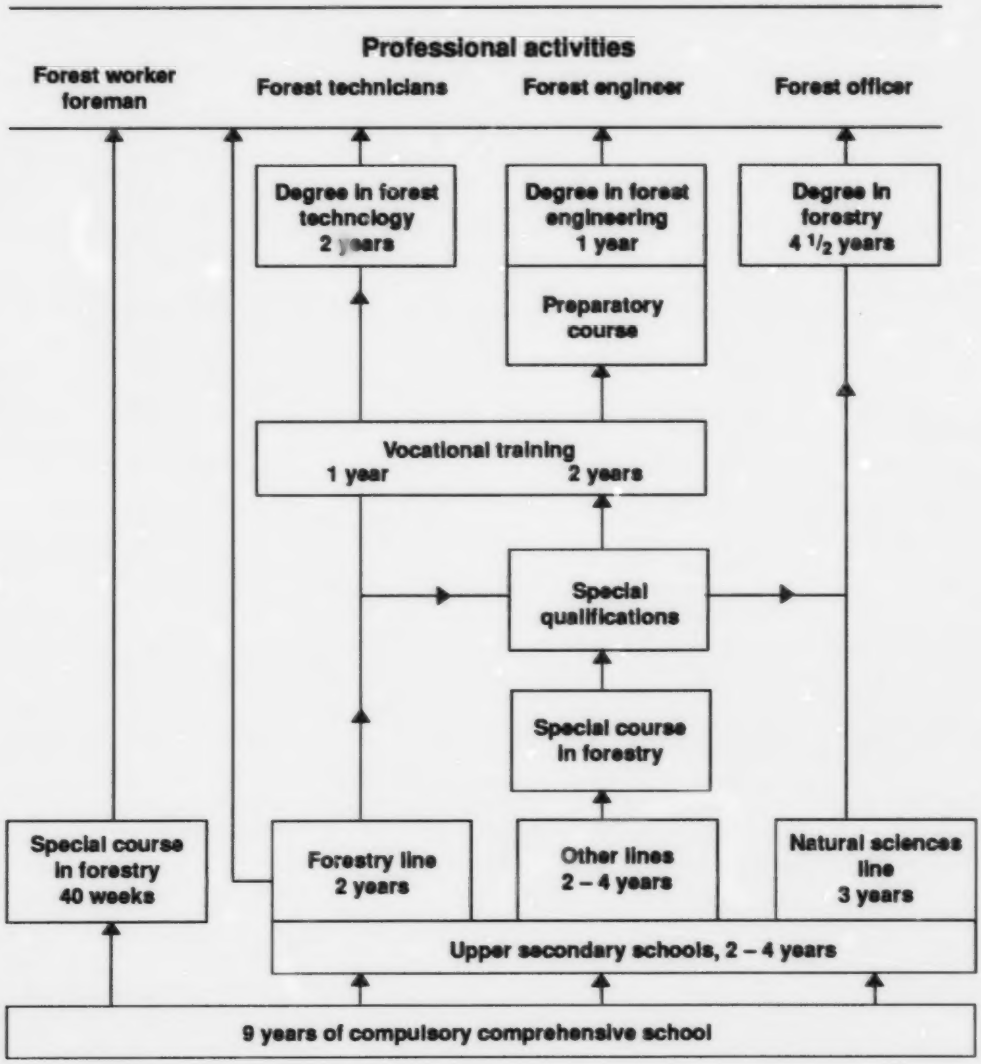

FIGURE 26. A flowchart outlining the components in Swedish forestry education.

10.2 Research and Development

Forestry research is centered in three institutions in each of Sweden and Finland — the universities, a tree improvement organization, and an operations research group similar to FERIC in Canada — all of which are funded cooperatively by industry and government. Research in Finland is also carried out by the Finnish Forest Research Institute. In both countries there are additional, smaller organizations engaged in forest research.

In Sweden, 76% of the university's forestry budget is spent on research and only 12% on education. Two-thirds of all forest research done in Sweden is carried out by the university's Faculty of Forestry. The faculty has five research programs focusing on:

- land use;
- inventory of forest resources;
- timber yield of a site;
- techniques concerning stand establishment and timber harvesting and utilization; and
- production of other resources and environmental assets, and their preservation, management, and utilization.

We visited one of the university's research stations in southern Sweden where it was reported to us that 80% of forestry research in southern Sweden is funded by industry, through a cooperative venture with government, spending slightly more than Cdn. $1 million per year. Private individual owners, who hold 80% of the forest land in southern Sweden, do not contribute to that research program. The research priorities in the south focused on air pollution, insect attack on seedlings, vegetation management, frost damage, root rot, windthrow, and declining timber quality, approximately in that order of priority.

That particular research cooperative is only a small example of Sweden's research programs. For example, the operations group, funded by industry, government, and the forest owners, has an annual budget in excess of Cdn. $4 million, about 40% of which is paid by the government. The Swedish tree improvement organization has a slightly smaller budget, which is also funded 50/50 by government and industry. The Swedish pulp and paper industry spends about 2% of its gross sales on research, the sawmilling industry about 1%.

10.3 Forestry Planning

Unlike British Columbia, both Sweden and Finland have long-term national forestry plans which include specific resource goals. The most recent plans in both countries were prepared in 1985, the Swedish plan for a period of 100 years to 2080 and the Finnish plan for a period of 15 years to the year 2000.

The Swedish plan projects the potential cut under three scenarios: (i) maintaining the present silviculture investment level; (ii) attempting to produce more wood; and (iii) providing for more multiple use. The first option is self-explanatory. The second option details the activities necessary to achieve more wood, such as more intensive care of young stands, increased fertilization and ditching, and increased use of lodgepole pine. Essentially, it models an intensity of forest management on private lands as high as that now carried out on company lands. The third option emphasizes management systems which favour environmental and recreational aspects by calling for less fertilization and ditching, phasing out of lodgepole pine, slightly longer rotations, increased natural regeneration, and more emphasis on the production of hardwoods. Interestingly, all options satisfy Sweden's present target of a sustained yield of at least 75 million m^3 per year. The Swedes are now wrestling with how to balance incentives for increased production of wood against incentives for increased production of environmental services.

The Finnish plan, called the Forest 2000 Programme, has as its main emphasis an increase in the country's timber harvests (see Appendix 4). Because the potential cut exceeds the current actual harvest, this objective could be achieved without increasing the rate of timber production. The Finns, however, have rejected this approach and are planning for an increase in timber production as well as harvest. The plan recognizes that multiple-use applications could decrease this cutting potential by 3 to 4% by the year 2000. This decrease is to be offset by an increase in the volume cut of approximately 25%.

There are three important points British Columbians can learn from Scandinavian forest planning. First, Scandinavian countries are setting targets for annual cuts in the future. Second, they are not planning to retreat from, but rather increase, their current annual cuttings. Third, they will accomplish this having regard for multiple-use requirements which focus more on forest management techniques than on the alienation of the working forest.

11 KEY RECOMMENDATIONS

From the many issues assessed and lessons learned during this Mission, we have developed the following key recommendations for British Columbia:

1. **Education:** We must improve the education and knowledge base of the general public, forestry workers, and landowners not presently contributing to the working forest.

   The general public in Scandinavia have greater confidence in forestry than their counterparts in British Columbia. This should be addressed through a forestry curriculum in the compulsory schooling program and through increased communications between the forestry community and the adult population, such as field tours, open houses, and advertising, combined with appropriate written and audio-visual material.

   Education for forestry workers must be improved at all levels. All forestry workers should be given at least some training. There must be better coordination between technical and professional courses to permit technicians to advance. Professional courses must be more field oriented and provide a better understanding of integrated resource management. A comprehensive continuing education program must be developed for all levels.

   While British Columbia does not have the same extent of private ownership as Scandinavia, private landowners should be encouraged to keep forestry land in forest production. Two avenues, that should be pursued immediately, include tax incentive schemes and a comprehensive extension service provided by both government and industry. If such programs fail, it may be necessary to legislate standards of forest practise on private land. The fundamental goal of such an education program should be to imbue all British Columbians with a strong forestry ethic.

2. **Forest Resource Goals:** We must establish what we expect from the forests by setting resource goals for timber production as well as all other uses of the forest. These goals should reflect increasing, not decreasing, timber production while at the same time make appropriate allowances for other uses of the forest.

   Our goals for timber production and our production methods should be determined having in mind trends in manufacturing capabilities and market demand, recognizing that flexibility is a key element for our future forests.

   British Columbia should focus more on environmentally sound forest management practises than on alienating more of the working forest as a means of preserving the environment.

3. **Forest Management Techniques:** Emphasis must continue to be placed on increasing wood quantity (growth rates) and quality (growth traits) through appropriate intensive management programs. Tree improvement and fertilization programs should be expanded. A program to assess herbicides and their alternatives should begin immediately.

   All timber production programs must be considered in light of their impact on other forest resources and must be developed to cost effectively minimize such impacts. To accomplish these goals, inventories of all forest resources must be substantially improved through expansion and updating, and significantly more work must be done in growth and yield modelling for managed forests.

We believe the adoption of these recommendations will significantly improve forest management in British Columbia, making it second to none in the world.

12 CONCLUDING COMMENTS

Missions such as ours provide foresters with an opportunity to compare the Scandinavian forestry experience with that of British Columbia. Scandinavian forestry, because it has evolved earlier and over a longer period of time than ours, offers many lessons. If we are to continue learning, it is important for us to remain in close touch with the experiences of our international colleagues.

APPENDIX 1: Mission members and itinerary

Mission Members

Mr. John R. Cuthbert
Assistant Deputy Minister and Chief Forester
Ministry of Forests
Province of British Columbia

Dr. T. John Drew
Director General
Pacific and Yukon Region
Forestry Canada

Mr. Lowell A. Johnson
Manager, Forest Resources
Houston
Northwood Pulp and Timber Ltd.

Mr. Blair J. Mayes
Assistant General Manager
Dunkley Lumber Ltd.

Mr. Brian D. Gilfillan
Assistant General Manager
Northern Interior Lumber Sector
Council of Forest Industries of British Columbia

Mission Itinerary

Sweden

27 May to June 6
Swedish Facilitator: Mr. Hugo Von Sydow
Sveriges
Skogsvardsforbund
The Swedish Forestry Association
Box 500
S-182 15 DANDERYD
Sweden

28 May
The Swedish Pulp and Paper Association
Villagatan 1
S-114 32 STOCKHOLM
Sweden
Contact: Mr. Goran C. Wohlfahrt
Vice-President, International

The Swedish Wood Exporters' Association
Box 26083
S-100 41 STOCKHOLM
Sweden
Contact: Mr. Lars Strangh
Managing Director

29 May
Domän
The National Forest Enterprise
S-791 81 FALUN
Sweden
Contact: Mr. Ingvar Ekholm
Forestry Director

30 May
Korsnas AB
Box 103
S-794 OO ORSA
Sweden
Contact: Mr. Jan Eklund
Regional Forest Manager

31 May
MoDo
Box 700
891 01 ORNSKOLDSVIK
Sweden
Contact: Mr. Lars Eriksson
Chief Silviculturist

The Institute for Forest Improvement
Box 3, S-910 36 SAVAR
Sweden
Contact: Mr. Ola Rosvall
Head of Northern District

1 June
SCA Skog AB
S-851 88 SUNDSVALL
Sweden
Contact: Mr. Jerker Karlsson
President

2 June
Karl Hedin AB Sawmill
Aktiebolaget Karl Hedin
Bergslagsvagen 49
773 00 FAGERSTA
Sweden
Contact: Mr. Karl Hedin
President

The Swedish Sawlog Association
Tingvallavagen 9M
S-195 31 MARSTA
Sweden
Contact: Mr. Ake Barklund
Director

3 and 4 June

Elmia Wood '89
Contact: Mr. Leif Stromquist
Stromquist Forest Consulting
Svardvagen 11 D
S-182 33 DANDERYD
Sweden

5 June

The National Board of Forestry
Skogsstyrelsen
S-551 83 JONKOPING
Sweden
Contact: Mr. Nils-Erik Nilsson
Head, Forecasting & Planning

Sodra Skogsagarna
S-351 89 VAXJO
Sweden
Contact: Mr. Henning Hamilton
Information Director

6 June

Kronoberg County Forestry Board
Skogsstyrelsen
Box 1233, 351 12 VAXJO
Sweden
Contact: Mr. Roland Persson
Head of Silviculture

Finland

7 June to 12 June

Finnish Facilitator: Mr. Torsten J. Nykopp
Managing Director
Finncell
Etelaesplanadi 2
POB 60
SF - 00101 HELSINKI
Finland

7 June

The Hon. Toivo T. Pohjala
Minister of Forestry
Parliament Buildings
HELSINKI, Finland

Central Association of Finnish Forest Industries
Etelaesplanadi 2
00130 HELSINKI 13
Finland
Contact: Mr. Samuel Kaurinkoski
Director of Forestry

Dr. Pavivio Piihinen and
Professor Ilpo Tikkanen
University of Helsinki
HELSINKI, Finland

Dr. Aarne Nyyssonen
Secretary General
The Finnish Academy of Science and Letters
Mariankata 5
SF-00170 HELSINKI
Finland

Metsateho
Fabianinkatu 9B
SF-00130 HELSINKI
Finland
Contact: Mr. Hannu Valtanen
Managing Director

Her Excellency
Mrs. Mary Vandenhoff
Ambassador of Canada to Finland
Rantapoku 22
HELSINKI, Finland

8 June

Tehdaspuu Oy
Salpausselankatu 26
PL 139
SF-45101 KOUVOLA
Finland
Contact: Mr. Esko Pakkanen
Director of Corporate Planning

9 June

Kymmene Corporation
Etelaesplanadi 2
P.O. Box 300
SF-00131 HELSINKI
Finland
Contact: Mr. Hans-Peter Blauberg
Senior Vice President
Forest Division

The Forestry Act

A new forest legislation was adopted by the Swedish Parliament in 1979. This legislation is based on the Acts dating from 1903, 1923 and 1948. The Government has issued an ordinance and the National Board of Forestry has announced regulations concerning the application of this Act. The Act has been in effect since 1st January, 1980, and was amended on some points in 1983.

Skogsstyrelsen
National Board of Forestry

The aim of the forest policy

§1 By means of proper utilization of their wood-producing capacity, forest land and forests growing on them should be managed in such a way as to provide a permanently high and valuable timber yield. This management should pay heed to nature conservation and other public interests.

General Provisions

§2 For the purposes of this Act, forest land is defined as:

1. land which is suitable for the production of timber and which is not used to any large extent for other purposes;
2. land where the presence of forest is desirable to protect against sand or soil erosion or against lowering of the timber line.

However, land lying wholly or mostly unutilized shall not be regarded as forest land if, by virtue of special circumstances, it is not desirable for such land to be put to use for the production of timber.

Land shall be considered suitable for the production of timber if, on the basis of customary principles of assessment, it can produce an average of at least one cubic meter of wood per hectare per year.

§3 This Act does not preclude the utilization of forest land for purposes other than for the production of timber.

§4 This Act shall not be applied where its provisions conflict with regulations issued under the provisions of the Nature Conservancy Act and other laws.

Establishing of stands on forest land

§5 New stands shall be established on forest land:

1. where after felling, or due to damage to forest, the timber-producing capacity of an area of land is not satisfactorily made use of;
2. where land is unused;
3. where forest is so thin or is composed of unsuitable tree species for the type of terrain to such an extent that its growth is considerably lower than the growth which is possible.

Measures on the bases of the first paragraph above shall be carried out in cases covered by categories 1. and 2. without delay. In cases covered by category 3. measures will be carried out within a reasonable period of time.

§6 If a forest stand is over-aged, and the timber-producing capacity of an area is exploited to only a minor extent, the County Forestry Board may decide to force clear cutting and the establishment of a new stand.

§7 Establishment of new stands shall be carried out using methods of regeneration which may be necessary to assure the growth of new forest which is satisfactory in terms of density and of composition in general. Regulations on methods of regeneration, scarification, planting of seeds and seedlings/transplants, tending of newly planted areas, and other measures in the above respect are issued by the government, or by a public authority designated by the government.

§8 Where required for silvicultural considerations, the government, or public authority designated by the government, may issue regulations prohibiting, or placing conditions upon:

1. the use of forest reproductive material of indigenous or of foreign origin, in establishing new forest stands;

2. trading with such material.

Forest reproductive material is defined as seed, seedlings/transplants, and other regeneration materials intended for establishing new forest stands.

§9 Cleaning newly-planted and young stands of forest will be carried out when forests are so dense, or otherwise are in a condition that production of valuable timber is significantly hampered.

If such forests are near the age when thinning may take place, the County Forestry Board may, in special cases, allow early thinning to be carried out instead of cleaning.

Forest shall be thinned when it is so dense that the production of valuable timber is being considerably inhibited.

§10 Forest owners are responsible for establishing and tending new stands.

§11 The County Forestry Board may, in special cases, grant exemptions to §§ 5, 7 and 9.

Cutting of forests on forest land

§12 Cutting on forest land may not take place in any other form than:

1. cleaning or thinning which benefits the growth of the forests;

2. clear cutting which is suitable for establishing new stands.

§13 Clear cutting of forest may not take place until it has reached such an age that only a minor increase in its average production can be achieved if it is allowed to remain standing. Average production is calculated as the average annual growth since the establishment of the stand.

The government, or the public authority designated by the government issues regulations laying down the lowest permissible age for clear cutting for various tree species growing in various parts of Sweden, on land of varying site quality class.

In special cases, the County Forestry Board may grant exemptions from the first paragraph above.

§14 It is the responsibility of the forest owner to see to it that clear cutting is carried out to an extent which will promote an even age distribution of the forest on his holdings. The government, or the public authority designated by the government issues regulations regarding the maximum portion of a holding which is allowed to be clear cut during a given period, and also what portion must be clear cut during that period. The latter portion may be no more than half of the portion which is allowed to be clear cut. In special cases, the County Forestry Board may grant exemptions from the first paragraph above.

§15 A holding is defined as that forest land which lies within the borders of one municipality and belongs to one and the same owner, unless otherwise provided in the regulations issued by the government, or public authority designated by the government.

§16 The County Forestry Board shall supply, on request, advance notice of decisions as to whether a specific cutting is consistent with the requirements of §13 or §14.

§17 Forest owners are obliged, under regulations issued by the government, or public authority designated by the government, to notify the County Forestry Board of cutting to be carried out on their land.

Forests difficult to regenerate and protected forests

§18 The government may order that forests difficult to regenerate due to an unfavourable location, or needed as protection against sand or soil erosion, or to prevent lowering of the timber line, be set aside as forests difficult to regenerate or protected forests.

§19 Cutting in forests difficult to regenerate and in protected forests may not take place without the permission of the County Forestry Board.

In connection with granting permission, the County Forestry Board may decide upon measures to limit or to minimize inconvenience and to ensure regeneration.

Permission is not required for cleaning or thinning which benefits the development of the forest.

Insect Damage

§20 The government, or public authority designated by the government may issue regulations for combating insect damage and removal of damaged forests, or storage of timber, and other measures required to combat the creation of breeding-grounds for insects.

Forest owners are responsible for ensuring that such measures are carried out. Other parties who have right of management over forest and timber are also responsible for preventive measures in connection with cutting and storage of timber.

Nature Conservation Aspects

§21 The government, or public authority designated by the government may issue regulations on the aspects of nature conservation which have to be taken into account in forest management, for example in relation to the size and form of the clear cut area, establishing new stands, leaving of tree-groupings, and the stretchings of forest roads.

These powers do not include the authority to issue regulations which are so far-reaching as to severely handicap utilization of land currently in progress.

Forest Management Plan

§21a There shall be a forestry plan for every holding with guidelines for forest management on that holding. The plan is to be drawn up in accordance with regulations issued by the government or the authority designated by the government.

The government or the authority designated by the government may issue regulations regarding exemptions from the first paragraph above.

Supervision

§22 The National Board of Forestry performs overall supervision of compliance with this law and with the regulations published under the provisions of this law. The County Forestry Boards perform more detailed supervision of compliance at county level.

§23 The supervisory authorities have the right to be supplied, on request, with the information and documents required for such supervision in accordance with this law.

§24 The supervisory authorities may prescribe or prohibit certain action where required to ensure compliance with this Act, and with any regulations issued under the provisions of the Act.

Certain action may by prescribed or prohibited when it has become clear that the advice and directions of the public authority have not been followed. However, in urgent cases, or where there exists other special justification, such prescriptions may be issued immediately.

In connection with a decision to prescribe or prohibit certain action, the supervising authority may order a monetary penalty in case of non-compliance.

Should a person fail to comply with a prescription the supervising authority may order the measure to be carried out at the expense of the person at fault.

§25 Should cutting result in relatively extensive and costly regeneration programmes, the County Forestry Board may, in connection with cutting being carried out, order guarantees to be furnished to assure completion of such regeneration measures.

Guarantees may also be required as a condition for permission being granted in accordance with §19.

If guarantees are not furnished in cases as provided for in the first paragraph above, the County Forestry Board may issue an order prohibiting forest cutting on the holding concerned without the permission of the County Forestry Board.

§26 The government may order special fees to be levied in cases covered by the provisions of this Act.

Responsibility and Appeals

§27 Payment of a fine will be sentenced upon any person who, either wilfully or through negligence.

1. violates any regulation issued under §8, Par. 1 or §20, Par 1.
2. violates §12 or §13, Par. 1.
3. violates the cutting limit under §14.
4. violates §19, par. 1, or the cutting regulation issued under the provisions of §19, Par. 2.
5. violates the cutting prohibition under §25.
6. fails to fulfill the duty of notification as laid down under the provisions of §17.
7. fails to comply with an order or violates any prohibition issued to ensure compliance with any regulation under §21.

In cases of minor violations there will be no conviction for liability.

In the event of several persons being accessories to a deed as referred to in the first paragraph above (§27), Chapter 23 §§4 and 5 of the Penal Code will apply.

In accordance with this Act, violation of any prescription or prohibition under penalty of a fine cannot entail any other prescription than a fine for the violation of that prescription or prohibition.

§28 Timber from cutting which represents a violation of this Act, or the value of such timber, shall be declared forfeit, unless this is manifestly unjust.

§29 Proceedings against a decision by the County Forestry Board under the provisions of this Act will be conducted in the form of an appeal to the National Board of Forestry. Proceedings against a decision by the National Board of Forestry will be conducted in the form of an appeal to the government.

§30 The authority concerned may order for its decision to be duly observed, notwithstanding any appeal.

Skogsstyrelsen
National Board of Forestry

Lbs offset, Jönköping 1987

Mailing address
S–551 83 JÖNKÖPING SWEDEN

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Vallgatan 6

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Nat 036 – 16 94 00
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Environmental consideration in forestry

Skogsvårdsstyrelsen

Laws referring to nature conservation in forestry

The Forestry Act
The Forestry Act presents guidelines as to how the forest is to be managed on a sustained yield basis. It contains directions and recommendations for establishing and tending of stands and for clearcutting operations. Also prescriptions for forest protection against insects and environmental considerations must be regarded.

Nature conservation can normally be combined with rational forestry. Forest owners can, of course, be interested to show even greater environmental concern than is required according to the Forestry Act.

The Broadleaved Deciduous Forestry Act

"The Broadleaved Deciduous Forestry Act" aims to protect for the future the following domestic tree species: elm, ash, hornbeam, beech, oak, wild cherry, linden and maple.

Normally after clear-felling a new broadleaved deciduous forest should be established.

The Nature Conservancy Act
Some areas have a greater demand for environmental considerations than are stipulated in the Forestry Act. The Nature Conservancy Act presents more detailed rules for the ways in which the ecosystem is to be protected and cared for in nature reserves and in nature conservation areas Draining of wetland and plowing of clear-felled areas to facilitate regeneration must thus be notified in advance.

The Ancient Monuments Act
Regulations to preserve national antiquities as old gravefields, and habitations are stipulated in the Ancient Monuments Act. The County antiquarian should be contacted before starting forestry operations near ancient monuments.

The Right of Common Access
The right of common access to private land is a very old traditional privilege in Sweden. It maintains the right of common access to private land for everyone with some rights and obligations implied. The picking of berries, flowers, mushrooms as well as occasional camping are thus allowed within certain limits.

Cover: Tengmalms Owl
Photo: Pertti Rauhamo
Illustrations: Nils Forshed
Print: AB Grafiska Gruppen Stockholm 1985

Skogsstyrelsen
The National Board of Forestry

Specific consideration

On some land specific consideration has to be shown. This applies primarily

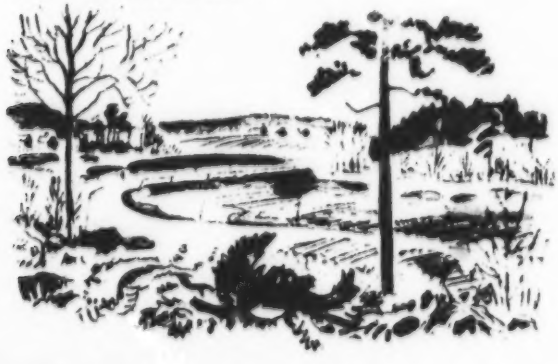
- near lakes and large waterways
- along coasts and in archipelagos
- near cultivated land, cultural environments and residential areas
- along roads with heavy traffic
- in areas of great importance to scientific nature conservation

What needs to be done varies from case to case. Some examples are shown below.

When cutting show consideration to the environment near lakes and waterways

When clearcutting save storm-resistent trees near residential areas

Widen and keep beautiful sceneries and save decorative trees along roads with heavy traffic



Save beautiful trees, bushes and edges of forests near cultivated areas

Contact the district forester

If you are uncertain about these environmental considerations, contact the County Forestry Board who will give you further information adapted to your holding.

General consideration

The Swedish forest is of great importance in many ways. It produces timber and job opportunities, provides possibilities to pick berries and mushrooms and is used for recreational facilities like hunting, fishing etc. Furthermore, it forms part of an ecosystem with plant and animal life. The forest is a striking element in the landscape and contains valuable cultural environments. A prerequisite for using it in all these ways is that we respect and balance competing interests.

This leaflet informs you of various kinds of environmental consideration to be practiced according to the Forestry Act.

Do not fertilize within 50 metres of lakes and streams. Avoid fertilizing shallow land.

Choose cutting sites with care especially on ridges of mountains and on hill sides.

Do not cut large new areas near previously cut sites until the reforested stands are above breast height.

Avoid disturbing birds and mammals during spring and early summer when burning or scarifying.

Adapt the forest roads to the landscape and protect spots with unusual flora and fauna.

Avoid draining swamps, small lakes, springs and brooks.

Some areas are of great value to plant and animal life as well as scenery. These areas are at the same time often of little importance to the timber production. Clearcutting on such land should be avoided. This implies small areas as

A small islands
B banks
C forest groves
D edges of forests
E grazing land close to buildings
F small left pastures
G rich vegetation fens
H around small lakes
I small and narrow swamps
J near springs
K near brooks and ravines
L on boggy grounds
M rocky and steep slopes
N flat stone land

Furthermore, save if possible

O old pines-preferably in groups
P dry trees standing or lying
Q trees and high stumps used for nesting
R old deciduous trees-preferably in groups
S rare deciduous trees-preferably in groups
T sallow, mountain ash, juniper etc. as fodder

Adapt the cutting site to the terrain and the surrounding forest. Do not clearcut too large areas.

Remove felling residues from banks, brooks and ditches.

Be careful with the environment close to ancient monuments or relics of ancient culture.

Remove felling residues from paths and roads. Avoid damaging these paths when hauling, scarifying or planting. Repair any damage that may occur.

Clean up loading and resting places. Be careful that no oil leaks occur.

Protect spots with rare plants and spots important to birdlife. Avoid forestry work in the vicinity of these during the mating period.

Haul the timber on damageable parts of the terrain only when frost or snow protects it from soil damage.

APPENDIX 3: Swedish rules for protection against insects

Background

Insects can mass-propagate and damage the forest severely. During the last years insects have mass-propagated and severely damaged growing pine and spruce forests. Every year insect damage causes losses of 100s of millions Sw. crowns.
The following noxious insects are the most common

Pine	The pine-shoot borer
Spruce	The eight-toothed bark beetle
	The six-toothed bark beetle

The insects propagate mainly under the bark on coniferous timber. If they have favourable access to such breeding material, they will mass-propagate and cause great damage. This has happened during the last years. Unbarked timber, wind-throws, cleaning and logging residues have been left to a great extent in the forests and served as suitable breeding grounds.

Forest protection rules stipulated in the forestry act.
To control the severe insect damage the Parliament decided in 1977 - by means of an addition to the forestry act of that time - on more rigorous rules for forest protection. These rules and some additions have been added to the forestry act of 1979.

- According to the new act protective measures must be taken to prevent breeding-grounds.
- If mass-propagating occurs or is feared, special control measures will be taken according to regulations stipulated at that moment.

In this brochure information is given about the forestry act and the regulations to this act, which are compiled by the National Board of Forestry.

Where are the regulations valid?

- on <u>all land</u>, that means not only on forest land but also in power lanes, new-built areas, parks etc.
- for <u>Scots pine and Lodgepole pine</u> within the whole country
- for <u>Norway spruce</u> within the whole country except the following areas in the inland of Norrland
  - the parishes of Transtrand, Särna and Idre
  - an area north resp west of the county roads 573 and 504 in the county of Jämtland (Särna - Lillhärdal - Sveg), the railway Sveg - Östersund - Gällivare and the county roads 97, 98, 394, 397 and 395 in the County of Norrbotten (the distance Gällivare - Finnish border by Pajala)

There are no claims to forest protection measures in spruce forests for the inland of Norrbotten, where the damage risk is insignificant.

Who is responsible?

- The land owner is responsible for both protective measures and combating when mass-propagating.
- The person who has disposal to forest and timber (i.e. buyer of standing crop) is responsible for protective measures when logging and storing.

Measures taken in damaged forests

Conifers damaged by storm, snow, fire or otherwise must be either

- barked in the forest or
- felled and extracted to motor road. This must always be done, if the timber volume exceeds 4 m^3 in a hectare. Also smaller quantities should be taken care of.

The extraction must be executed in time to treat or transport the timber, before the new insects are hatched, that is before the dates listed for extraction in the table on page 6.

Measures taken with cleaning, clearing and logging residues

• Stems must not be left.

Felled stems or parts of stems of fresh conifers thicker than 5 cm on bark must not be left in the forest. This is only allowed if the timber is barked or barked in strips. Strip barking must be carried out in such a way that a maximum of 5 cm bark strips are left. Pine must be barked before June 1, spruce and lodgepole pine before July 1.

• Small amounts of residues may be left.

When cleaning and clearing only 100 felled conifers thicker than 5 cm on bark at the stump cut may be left per hectare. Only 10 of these may be thicker than 10 cm. When logging only 200 units per hectare may be left of

- butts, timber, pulpwood etc. (1 m = 1 unit)
- felled trees, 7-10 cm at the stump cut (1 tree = 1 unit)
- some left felled trees thicker than 10 cm (1 m = 1 unit)
- tops thicker than 7 cm at the stump cut (1 top = 1 unit)

Only 50 of 200 units may be butts or tops.

• During certain periods residues may be left.

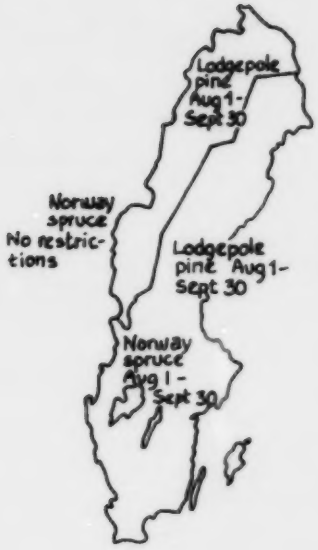
These periods occur after the insect swarming. The residues will dry until next year, when it is no longer suitable as breeding material.

SCOTS PINE

- In Norrland except the county of Gävleborg and the parishes of Transtrand, Särna and Idre residues may be left from June 1 - July 15. [1)]
- In the remaining parts of the country residues may be left from May 15 - July 15. [1)]

---

1) If stem parts thicker than 5 cm are cut to half meter long pieces, the time will be prolonged until August 15, only when cleaning or clearing.



NORWAY SPRUCE

- In the inland of Norrland residues may be left the whole year.
- In the remaining parts residues may be left from August 1 - September 30.

(Only tops and felled trees thinner than 10 cm are referred to when logging).

LODGEPOLE PINE

- All over the country residues may be left from Aug 1 - Sept 30.

(Only tops and felled trees thinner than 10 cm are referred to when logging).

Measures taken after severe attacks

After severe and extensive insect attacks or danger for such (forest fire, storm felling, snowbreak etc) the National Board of Forestry will announce measures to be taken. An example is the combating of the eight-toothed bark beetle in Värmland.

Land owners who discover great insect attacks on their forests must report this as soon as possible to a County Forestry Board.

Measures taken for timber extraction to motor road

Unbarked fresh coniferous timber logged before and during the insect swarming must be extracted to motor road in time to be processed or transported before the insects are hatched. This means that the timber extraction to motor road must be finished at least one month before the time of transportation.

Tree species	Area - see maps	Timber logged before	Must be extracted to motor road latest	Treated or transported latest *)
SCOTS PINE	Norrland except Gävleborg and parishes of Transtrand Särna and Idre	June 1	June 15	July 15
	Remaining parts of the country	May 15	June 1	July 1
NORWAY SPRUCE	The whole country except the inland of Norrland	July 1	July 1	August 1
LODGEPOLE PINE	The whole country	July 1	July 1	August 1

*) valid from 81-09-01

Timber logged after the dates marked in the table may be left all winter until the latest extraction date next year.
To avoid timber damage, i.e. insect hole or blue stain it must be transported early in the spring before the insect swarming.

Measures taken when storing timber

Unbarked fresh coniferous timber must not be stored in the forest or nearer conifers than 3 km according to the dates mentioned in the right column on page 6.

Timber may be stored after these dates, if it is protected in some of the following ways:

- Barking
- Covering of spruce stacks i.e. with plastic
- Extracting the upper logs of the spruce stacks after the insect swarming
- Sprinkling
- Water storage
- Spraying with insecticides (must be notified to the County Forestry Board).

These regulations concerning timber storage will enter into force on September 1, 1981.

General information concerning forest protection against insects

To protect your forest against insects according to the forestry act, you as a forest owner must observe the following rules:

- Young stands must be cleaned at a height of 2-3 m. The felled coniferous trees are at this time thinner than 5 cm and unsuitable for breeding material.
- Process the timber to the minimum dimensions valid for various assortment systems when logging.
- Log in time for the timber to be transported, before the insects are hatched. Try to extract the timber to motor road at least a month before the latest date stipulated for further transportation.
- Check the forest yearly. Utilize storm-felled, snow-broken and in other ways damaged trees. Process them and extract the timber before the summer. Control the areas around the latest loggings first.
- Leave no timber after logging or clearing in power lanes, boundary lines, along roads etc.

The maximum amount of timber and timber residues that may be left in the forest are stated in the regulations of the forestry act.
The interest of every forest owner, however, should be to leave less.

FOR FURTHER INFORMATION CONTACT YOUR COUNTY FORESTRY BOARD.

Skogsstyrelsen 1980
National Board of Forestry
S-551 83 JÖNKÖPING SWEDEN
Lbs offset, Jönköping 1984

APPENDIX 4: Finland's Forest 2000 Programme

Eripainos Silva Fennica 1/1986

Silva Fennica 1986, vol 20 n:o 1: 35–44

The Forest 2000 Programme

Guidelines for developing Finnish forestry and the forest industries

TIIVISTELMÄ: METSÄ 2000-OHJELMA

The Forest 2000 Programme. Guidelines for developing Finnish forestry and the forest industries. Tiivistelmä: Metsä 2000-ohjelma. Silva Fennica 20 (1):35–44.

The Forest 2000 Programme is a long-term programme for forestry and the forest industries. It attempts to obtain a better integration of timber production and other forms of forest use. The total annual cut is to be increased by 15 mill. m^3 by the year 2010. This is almost one third greater than the level during the first few years of the 1980's. In order to achieve the cutting targets, the cut area will have to be increased by almost a third by the turn of the century. The area of thinnings will experience the greatest increase. Considerable changes are proposed in silvicultural and basic improvement work. According to the programme, the growth of the raw-material base and the consumption of the wood-based products will permit an annual increase of about 3 % in the production of the forest industries as a whole until the end of the century. This would be the same as the target growth rate of the GNP.

Metsä 2000-ohjelma on metsä- ja puutalouden pitkän aikavälin ohjelma. Siinä pyritään sopeuttamaan entistä paremmin toisiinsa puuntuotanto ja metsien muut käyttömuodot. Vuoteen 2010 mennessä on tavoitteena metsien vuotuisen hakkuumäärän suurentaminen 15 milj. m^3:llä eli lähes kolmanneksella 1980-luvun alkuvuosiin verrattuna. Hakkuutavoitteiden saavuttamiseksi on hakkuupinta-aloja suurennettava. Voimakkaimmin kasvaa harvennushakkuiden ala. Metsänhoito- ja perusparannustöihin esitetään huomattavia muutoksia. Ohjelman mukainen raaka-ainepohjan kasvu ja metsäteollisuustuotteiden käytön kehitysnäkymät mahdollistavat arvion mukaan koko metsäteollisuuden tuotannon nostamisen vuosittain noin 3 prosentilla vuosisadan loppuun saakka. Se olisi sama kuin yleisesti tavoitteeksi asetettu bruttokansantuotteen kasvuvauhti.

Key words: Timber production, cutting targets
ODC 905.2:72:83:916
Correspondence: University of Helsinki, Department of Forest Products Marketing, Unioninkatu 40 B, SF-00170 Helsinki, Finland
Approved on 26. 2. 1986

The task and organization of the programme

The Forest 2000 Programme sub-committee was appointed by the Economic Council on the 21st of February 1983. The task of the sub-committee was to draw up a long-term programme for forestry and the forest industries. The sub-committee consisted of a group of executive representatives from various important interest groups, as well as a working committee subordinated to it. Working groups for silviculture and forest management, for timber procurement, for the development of the forest industries, and for the multiple-use of forests were set up by the sub-committee to procure the information for drawing up the programme.

The elements of the programme

Alternative analysis was used in defining the cutting and timber production targets of the programme, and in determining the development prospects of the wood-processing industry. This meant that the most important environmental factors, such as trends in the demand for products of the forest industries and the overall effect of the multiple-use of forestry, could be taken into account in the profitability calculations carried out for the comparison. The goals of the Forest 2000 Programme were finalised on the basis of the results of the alternative calculations. As well as defining the goals, an attempt was made to develop the economic, industrial and forest policy instruments needed to achieve these goals.

Methods

A modified version of the MELA forest calculation programme, recently developed by the Finnish Forest Research Institute and the Department of Forest Mensuration (University of Helsinki) was used in designing the cutting and timber production programme. In the first stage, MELA simulated the management options for the stands, and the development of the stands when managed accordingly. In the second stage, the programme assembled from these management alternatives a cutting and timber production programme implementing the cutting removal or other targets set for the management of the forests.

When preparing the different options available to the Forest 2000 Programme, the forest calculation programme was used both for defining the combination of measures designed to produce the desired removal, and for determining the development of the growing stock and the removal achievable through a particular combination of measures. At the same time, an attempt was made to ensure that the achieved solution was also economically optimal.

The analysis of the cutting and timber production options also included a profitability comparison of the different alternatives. Cost-benefit analysis was used in the comparison. The result showed that as the cutting removal increased, the profitability only improved if industry was able to utilize all the roundwood which became available. At least this was the case when sustained yield management was practised, i.e. where the cutting potential did not decrease in the future.

The objectives of the programme

The starting point when practising a forestry and wood-based economy is to increase the prosperity of society throught the exploitation of the forests. The most important aims of forest policy are: 1) support for the general targets of economic policy, 2) balanced development of the different forms of forest use, 3) complete utilization of the productive capacity of forest land, 4) economic viability of the measures applied, 5) matching the timber assortment structure and volume of timber utilized with the cutting potential, and 6) the creation of conditions favourable for viable forest-based industries.

Considerable investments were made in silvicultural and basic improvement work in Finnish forestry during the 1960's and 1970's in order to increase timber production. As a result, the annual cutting potential has increased since the middle of the 1950's by 13−14 mill. m^3. At the same time, the use of wood as fuel and the export of roundwood have considerably decreased. Timber imports have correspondingly increased. Although industrial wood raw material consumption has more than doubled, the overall trend in the annual cut has slightly decreased. An increasing proportion of the cutting potential has remained unexploited since the middle of the 1960's. The difference between the annual allowable cut and total removal, mainly in the form of large-dimensioned spruce and non-coniferous cordwood, has over the years been about 10 mill. m^3/a. This is equivalent to a good 15 % of the potential cut.

Following the objectives and factors outlined above, the main emphasis in the Forest 2000 Programme is directed at increasing the level of cuttings. At the same time, attention is paid to the role of silvicultural and basic improvement work in increasing timber production.

The multiple-use of forests

The programme attempts to obtain a better integration of timber production and other forms of forest use. The total value of all the subsidiary forest products was, at the beginning of the 1980's, approximately 10 % of the value of the timber cut annually along long-distance transport routes. The area of forest land reserved mainly for protection and recreational use totals 1.7 mill. ha. This area is expected to increase by only about 0.1−0.2 mill. ha by the year 2000.

Multiple-use applications are expected to decrease the annual cutting potential by a total of 2.2 mill. m^3 (3−4 %) by the year 2000. The programme notes that more attention should be paid to the needs of multiple forest use, in addition to timber production, both in planning and in the measures employed in forestry.

Cutting and timber production targets

The removal targets of the Forestry 2000 Programme, i.e. the targeted amounts of roundwood harvested from the forests, are presented in Table 1 and Fig. 1.

The total annual cut is to be increased by 15 mill. m^3 by the year 2010. This is almost one third greater than the level during the first few years of the 1980's. Achieving this

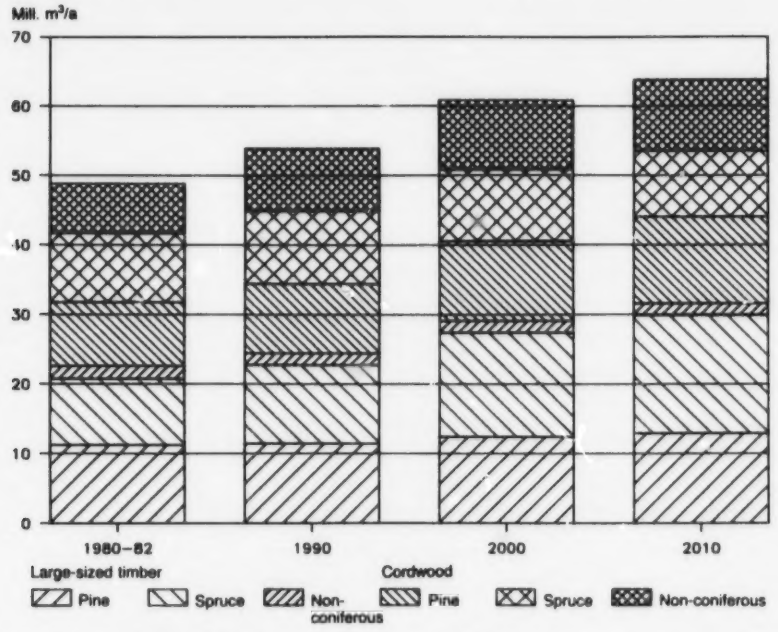


Fig. 1. The removal targets of the Forest 2000 Programme. The cut can be increased annually by 650 000 m³ until 2000. Almost half of this increase is large-sized sprucelogs, and a third pine and non-coniferous cordwood.

Table 1. The removal targets of the Forest 2000 Programme.

Type	Implemented	Targets		
	1980–82	1990	2000	2010
			mill. m³/a	
Total	48.8	54.0	61.0	64.0
Pine	20.5	21.5	24.0	25.5
Spruce	19.4	21.8	25.3	26.5
Non-coniferous	8.9	10.7	11.7	12.0
Of which:				
Large-sized timber	22.6	24.5	29.2	31.7
Pine	11.3	11.5	12.5	13.0
Spruce	9.5	11.3	15.0	17.0
Non-coniferous	1.8	1.7	1.7	1.7
Cordwood	26.2	29.5	31.8	32.3
Pine	9.2	10.0	11.5	12.5
Spruce	9.9	10.5	10.3	9.5
Non-coniferous	7.1	9.0	10.0	10.3

goal presupposes that the cutting potential is exploited to a greater extent than was the case during the 1970's and 1980's. Half of the increase in cuttings would be large-sized spruce logs and a fifth deciduous cordwood. Cuttings of these timber assortments have decreased during the past few years. The cutting targets of other timber assortments, apart from large-sized hardwood logs, are also to be increased. In order to achieve the cutting targets, the area cut will have to be increased by almost a third by the turn of the century (Fig. 2). The annual area of thinnings will experience a considerable increase (70 %).

Considerable changes are proposed in silvicultural and basic improvement work (Figs. 3 and 4), e.g. the proportion of natural regeneration will be increased in forest regeneration work. A start has already been made on this part of the programme. Site preparation and the cleaning of regeneration areas will

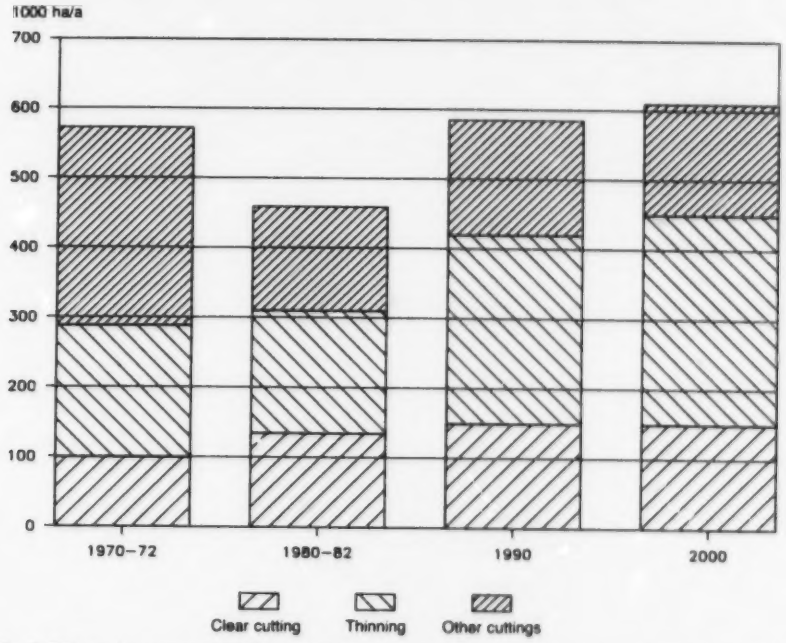


Fig. 2. The cutting areas of the Forest 2000 Programme. The area of the annual cut will increase by almost a third from the present level. The main emphasis is on thinnings, but the area of regeneration cuttings will also increase.

increase to some extent; a technology less harmfull to the environment will be used on these sites. Artificial regeneration will see a slight shift from planting to sowing. The greatest changes will occur, however, in basic improvement work. All new drainage work is to be completed before the end of the century. The amount of redrainage, which includes ditch cleaning and supplementary drainage, should triple by the year 2000. The level of forest fertilization is expected to double. It is also proposed that the pruning of standing trees be increased.

The calculations indicate that the programme will lead to a 20–30 % increase in the costs of silvicultural and basic improvement work by the end of the century, and an increase of about 10 % in state-funded forest improvement work.

If the targets of the programme can be implemented in their proposed form, then the volume of the growing stock will increase by about 10 % and the annual increment by about 20 % by the year 2020 (Fig. 5). The growing stock will change from its present composition to one that is more pine dominated.

The fact that the cutting and timber production targets are also presented in the programme by area (by forestry board district) will presumably assist in the planning the implementation of the programme on a regional basis.

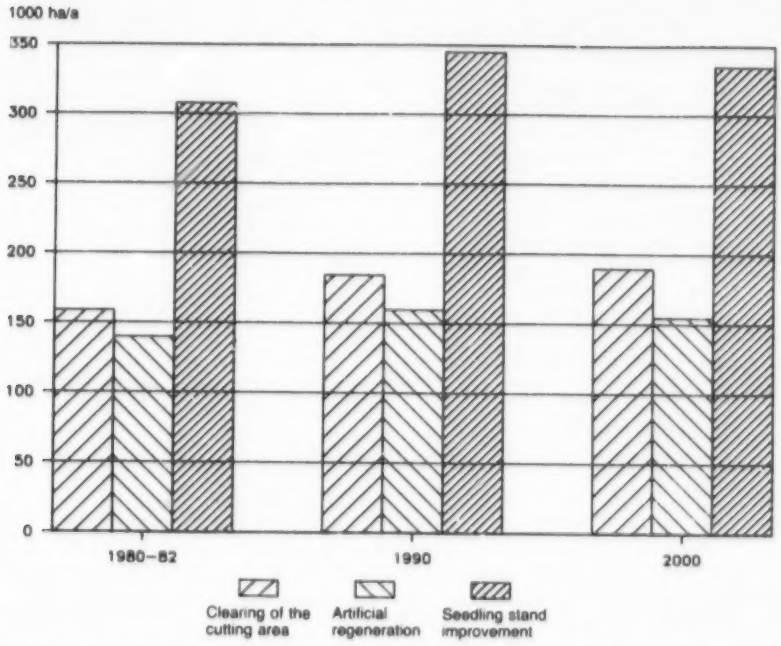


Fig. 3. The silvicultural targets of the Forest 2000 Programme. The need for silvicultural work will increase slightly from the present level.

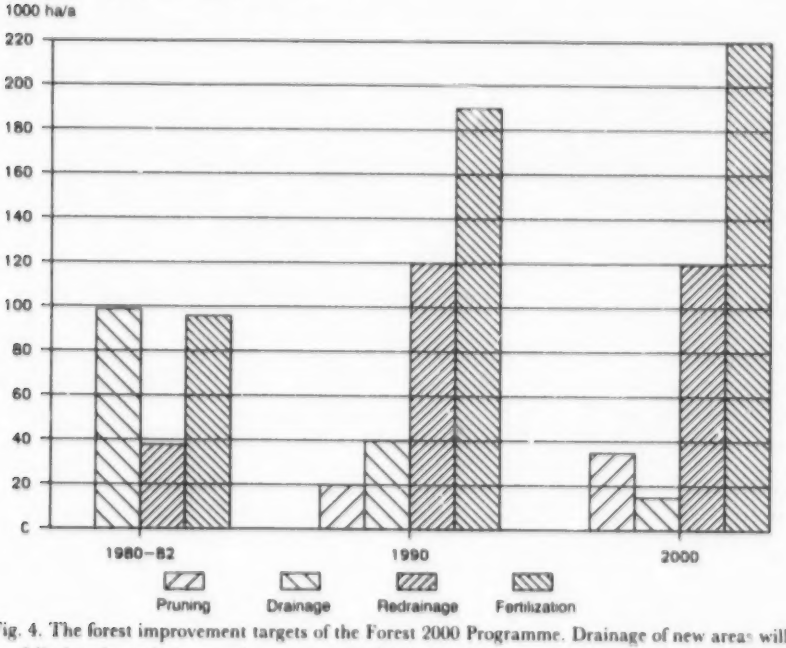


Fig. 4. The forest improvement targets of the Forest 2000 Programme. Drainage of new areas will fall sharply and, in practice, cease completely by the turn of the century. The need for redrainage will correspondingly increase. It is recommended that pruning of standing trees be made eligible for forest improvement funding. It is also recommended that the annual level of forest fertilization be increased to that prevailing at the beginning of the 1970's.

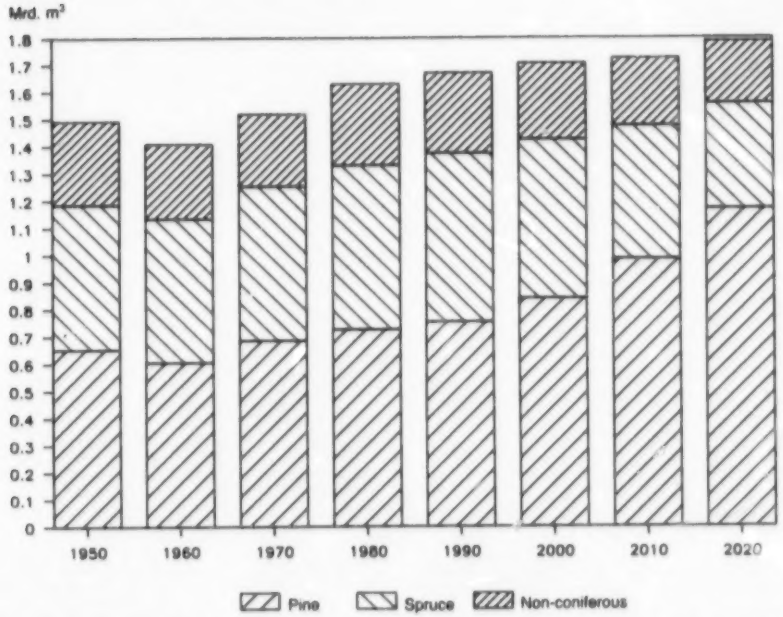


Fig. 5. Development of the growing stock volume. The cutting targets have been set at a level below the annual increment. This means that the growing strock volume will increase by 10 % from its present level by the year 2020. The proportion of pine in the growing stock will considerably increase.

The development possibilities of the forest industries

The development possibilities of the forest industries up to the year 2000 are examined in the programme by taking the cutting targets as the starting points. The predictions indicate that the consumption of the most important groups of products will grow during the period 1980–2000 as follows:

Product group	Whole world	Western Europe
	Annual growth %	
Sawnwood	1.1 . . . 1.5	−0.7 . . . 0.7
Wood-based panels	2.2 . . . 4.7	2.4 . . . 4.6
Paper	3.3 . . . 3.7	2.5 . . . 2.8
Paperboard	2.8 . . . 3.5	2.0 . . . 2.8

According to these estimates, the total demand for forest industry products, weighted by the present structure of Finnish exports, will grow at a rate of about 3 % a year until the end of the century.

According to the targets of the programme, the raw material base of the forest industries will increase annally by 650 000 m³. Almost half of this amount will be large-sized spruce logs, and a third pine and non-coniferous cordwood. It appears that products based on kraft pulp will remain sufficiently competitive, consequently there will continue to be a demand for them in the future. A clear structural change has taken place in Europe dur-

ing the past few years in the supply of spruce sawnwood and non-coniferous pulp. Pulp production based on extensive forest plantations has appeared in Continental Europe, especially in Spain and Portugal. New sawmill capacity has also been built in Continental Europe. This production is, on the basis of its location, already more competitive on the European market than its Finnish equivalent. It is clear that in the coming years the Finnish forest industries will have to make greater investments in product development and marketing.

It can be assumed on the basis of past developments that the proposed cutting targets can be achieved as long as competitive production can be ensured:

	Implemented 1960–80	Forest 2000 1980–2000
	Annual growth %	
Forest industries		
– volume of production	+ 4.4	+2,6...+3.3
– wood consumption	+ 2.3	+1.2
– consumption of non-coniferous pulpwood	+11.2	+2.4
– consumption of large-sized spruce logs	+ 3.0	+2.5

Four development alternatives for the forest industries, which differ from each other with regard to the volume of the spruce logs used, are analysed in the programme. The results are presented in Table 2 and Fig. 6.

It appears that the raw material situation for the sawmill industry will remain satisfactory for the rest of the century. The production of pine sawnwood could be increased slightly compared to the level at the beginning of the 1980's, and that of spruce sawnwood considerably increased if the product is made competitive on the international markets. However, if the cutting targets are to be met, it will probably be necessary to direct an increasing proportion of large-sized spruce logs to the pulp industry, mainly for the production of mechanical pulp. This means that, of the presented alternatives, III and IV are the most realistic.

Owing to unfavourable competition in the market for particle and fibreboard, significant increases in the production of these products will be unlikely. The future production of plywood depends on whether the proportion of spruce in the product can be increased.

Growth in the forest industries will seemingly take place almost entirely in the pulp and paper industry. The potential annual

Table 2. The development possibilities of the primary forest industries according to the Forest 2000 Programme.

Product group	Implemented 1980–82	Production possibilities in 2000			
		Alternative			
		I	II	III	IV
		1000 m^3/a			
Coniferous sawnwood	8 522	11 900	10 600	9 500	8 500
– pine	5 106	5 700	5 700	5 700	5 700
– spruce	3 416	6 200	4 900	3 800	2 800
Plywood	613	770	770	770	770
Particle and fibreboard	970	1 000	1 000	1 000	1 000
		1000 mt/a			
Pulp	7 101	10 400	10 800	11 400	12 200
– mechanical	2 387	4 100	4 500	5 100	5 900
– chemical	4 714	6 300	6 300	6 300	6 300

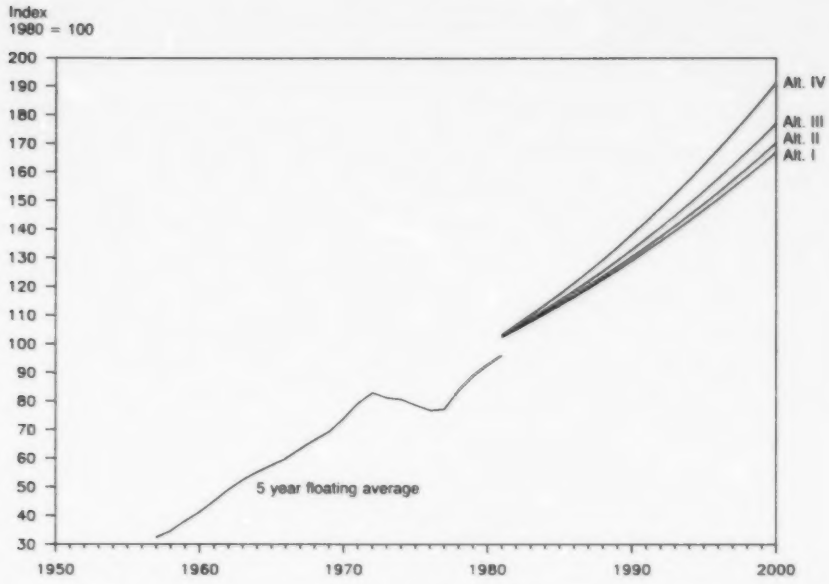


Fig. 6. The development prospects of the forest industry. The production volume of the forest industries as a whole can be increased by about 3 % a year. This corresponds to the estimated long-term increase in the demand for forest industry products.

growth in the production of pulp until the end of this century is 2–3 %, for chemical pulp 1.5 %, and for mechanical pulp 3–5 %. Production in the paper and paperboard industry could grow annually by 3.5–5 %.

According to the programme, the growth of the raw material base will permit a 3 % annual increase in the production of the forest industries as a whole up until the end of the century. This would be the same as the target growth rate the GNP. However, the increased production presupposes that the functioning, competitiveness and raw material supply of the forest industries is maintained, and that their wood consumption structure is adapted to the structure of the cutting targets.

The means available for achieving the targets

The targets of the programme are ambitious and demanding. The measures, as presented, will presumably not be enough. It will be necessary, therefore, to devise additional measures to supplement the programme while it is being carried out.

The most important of the means available for increasing timber supply are forestry planning and an increase in the advice and services directed at the forest owners. By the beginning of the 1990's, individual forestry plans will have been drawn up for 90 % of the privately-owned forest area. Personal advisory services, and the execution of forestry plans, will have to be made more effective. All the forest owners, including those living out-

side the area where their holdings are situated, will have to be brought within the scope of the advice and service facilities. This will require a staff increase of about 50 in the district forestry boards, as well as in the number of staff needed by the local forestry associations.

Other means of increasing timber production proposed in the programme include the development of forest ownership, forestry legislature and forest taxation, increasing the effectiveness of forest cooperation at the regional level, and improving the functioning of the roundwood markets. Active and constructive cooperation between the different interest groups is essential.

Economic, investment, energy and foreign trade policy, research and development work, and the effective marketing of wood-based products, all play a central role in strengthening the demand for timber.

Monitoring and updating the programme

Social development and environmental conditions, such as acid precipitation, can bring about relatively rapid changes in forest management and in the forest ecosystem. It is also difficult to predict the activities of the forest owners and forest industries. Implementation of the programme must be monitored continously, and its targets and choice of means checked at least every 5–10 years. The continuity of the necessary research work, data systems and data registers, as well as development of the planning models, must be ensured. Since the Forest 2000 Programme is a long term project, it must be supplemented, at fairly short intervals (about 5 years), with a programme in which the targets and measures are scheduled annually, and which are checked and continued each year.

APPENDIX 5: Selected reference material

References are listed only once even though they may cover more than one subject matter.

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